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THE PHILOSOPHY OF GENERAL SCIENCE.[1]

BY EDWIN E. SLOSSON

Director, Science Service, Washington, D. C.

Sometime ago I had lunch with a leading actor of a popular play. He came late and looked surprised.

"I beg your pardon for my tardiness," he said, "but we had an extra rehearsal this morning."

"How was that?" I asked. "Your play has been running over a year and you must all be familiar with it by this time."

"That's the trouble," he replied. "We are so familiar with it that we are apt to get careless and hurry or retard some speech or business. The stage manager keeps time on every scene and if it is half a minute off either way, the actors in it get a reprimand. If the play as a whole deviates from the schedule by three minutes, the company is called for a complete rehearsal next morning."

Now this was not one of these helter-skelter, flitter-flurry, modern plays, that strive to outspeed the movies. It was a dreamy, leisurely, oriental play, in which the gestures were deliberate and the conversation interrupted by long pulls at the hookah. Yet every movement was calculated and every second counted, even when the actors were motionless and the stage darkened. The actors had only 140 minutes in which to awaken the interest of a more or less indifferent and distracted audience, and to produce an indelible impression on their minds, and every minute must be made to count.

This, I think, has a lesson for teachers. You have fifty minutes in which to awaken the interest of a more or less indifferent and distracted audience and to produce an indelible impression on their minds, and you too should make every minute count. This does not mean that you have to hurry. The play, as I said, was

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a leisurely one. There is reason to think that we are putting our students through at too rapid a pace now. Professor Dearborn says that it is wrong "to be too fast, forever putting facts into the mind while never providing time to use them in thought." But we ought to be at least as careful in economizing the time of our students as the theatrical manager is in economizing the time of his auditors. That means careful planning as to just what points can be hurried over and what should be allowed more time; where cuts can be made and where "stage business" should be elaborated.

You realize the importance of this as you prove by your presence here, and I am not going to take up any of your valuable time in giving advice at random from my inexperience about what should be included in the science course and how it should be taught. But I do welcome the opportunity to talk to you about a side of the work that seems to be neglected in the absorbing discussion of ways and means, and that is the fundamental principle of General Science, why it has a right to assert its claims as a complement to the special sciences, and why it should be welcomed by them as an ally rather than being regarded with suspicion as a rival.

General Science bears the same relation to the several sciences as the League of Nations bears to the nationalist movement, and it is meeting with the same sort of opposition. It is an effort at the unification of knowledge, and it is attacked equally by those who think it is impossible but desirable, and by those who think it is undesirable but possible.

General Science is hampered by its name. General Science sounds like "superficial science," and superficial science sounds like "inaccurate science," which sounds like nonsense. If the study had been launched under some such name as "synthetic science," it would have been less misunderstood by outsiders, and it would have impressed upon its practitioners the idea that it differs from the several sciences not only in grade, method and arrangement, but also, and more significantly, in point of view. General Science is not a crazy-quilt, made up of patches torn from the various sciences. On the contrary, the various sciences consist of patches torn from the seamless robe of truth, which it is the object of General Science to present in its pristine unity, its natural integrity.

Historically, General Science is the mother of the sciences who now disown her. The point of view of General Science is

that of the natural philosophy of the eighteenth century, the age of Franklin, Rumford, Humboldt, Leibnitz, Kant, Goethe, Linnaeus, Berkeley, Buffon, Diderot, and the French Encyclopedists. None of these could pass a college entrance examination in any particular science. They were what would now be called "smatterers," yet they cannot be said to have superficial minds. It may seem presumptious to claim such distinguished ancestry for a humble high school study, yet General Science bears two evidences of such heredity, its humanitarian aspect and its cosmic conception. Eighteenth century science was distinguished from the periods that preceded and followed it by its effort at an all-embracing point of view and its belief that science should contribute to human welfare. I think I see signs of a revival of this spirit. The twentieth may turn out to be the synthetic century, as the nineteenth was the analytic century. If so General Science may take a leading part in the movement if it follows its own philosophy and develops its own methods instead of being content to pick up such scraps of useful information as it can lay hands on and stick them together anyhow.

The difference between General Science and the several sciences is essentially the same as that between the family and the club. The family is a natural group formed of diverse individuals. The club is an artificial organization of like-minded individuals selected for congeniality. That is why it requires more broadmindedness and adaptability to live in a family or village than in a club or city. As Chesterton puts it with his customary pungency:

"The man who lives in a small community lives in a much larger world. He knows much more of the fierce varieties and uncompromising divergencies of men. The reason is obvious. In a large community, we can choose our companions. In a small community our companions are chosen for us. . . . There is nothing really narrow about the clan; the thing that is really narrow is the clique."

So the man who finds the natural complexities of the clan and incompatabilities of the family too much for his peace of mind, flees to the club in search of a simpler and quieter life. So too, the scientist who confines himself to some selected group of natural phenomena, say the modulus of elasticity of non-ferrous metals, or the second law of thermodynamic, or the constitution of organic-metallic compounds of the paraffin series, can safely

ignore the rest of the world. If asked a question about anything outside his prescribed field, he can modestly admit his ignorance, —no, rather, proudly assert his ignorance, for he gains instead of losing prestige by that admission. People naturally, though not always justifiably, assume that a man who knows nothing about so many things must know a great deal about something.

But you teachers of Science in Senior and Junior High Schools who have your topics presented to you in the raw, cannot so pick and choose, and so you do not have so easy a time of it. If, for instance, the subject of your lesson is an automobile, you cannot dodge questions because they refer to matters out of your jurisdiction and over the boundary of another science. You may have to deal with the modulus of elasticity of non-ferrous metals, the second law of thermodynamics, and the constitution of tetra-ethyl lead all in the same hour, and what is still more difficult, you will have to show their relationship to one another, and how they all contribute to the working of the machine.

You are not dealing with prepared specimens, preserved in formaldehyde like fish in museum bottles. Your subjects are cast upon your desk alive and kicking, freshly caught by your students from the flowing stream of current events. The teacher of high school science cannot draw upon a barrel of old lectures. His topic for the day may be the biplane flying by the window or the mosquito flying about the room. The text for the morning lesson may be given to him in the form of a clipping from the morning paper. He is put through a daily intelligence test by his pupils, and this requires a broadness of interests, an alertness of mind, and a proficency in fundamental principles that is not found in all scientists. That is why good teachers of elementary science are so hard to find.

The specialist knows his own ground and so has the advantage so long as he can keep to it. Maarten Maartens, the Dutch novelist, tells of a Leyden student who, in the study of zoology, devoted himself to the elephant exclusively. When he came up for examination, he found three questions on the paper which he answered in this fashion:

How many legs has the centipede? The elephant has four legs.

How many tusks has the rhinoceros? The elephant has two tusks.

How many wings has the dragonfly? The elephant has no wings.

His paper was the only one free from errors, so he was awarded *magna cum laude*.

But outside the artificial atmosphere of the classroom, the specialist cannot keep to his specialty. As soon as he comes into contact with actuality, with real things and real problems, he will find that the sciences are all mixed up in every single thing; that he cannot comprehend the flower in the crannied wall, all in all, by botany alone, but has to consider it in the light of chemistry, physics, geology, entomology, meterology, and anthropology, and he may find himself in the realms of metaphysics and theology if he goes far enough. Even the elephantine specialist could not understand his particular pachyderm without entering into comparative zoology which might well have involved consideration of the centipede, the rhinoceros, and the dragonfly. All nature is one and we should never forget that in contemplating her various aspects as described in the several sciences.

I must confess that I am preaching the opposite doctrine from what I advocated when I first talked to teachers thirty-five years ago. At that time I urged the desirability of intensive study of the perfect mastery of the narrow field. I do not take back a whit of what I used to say but I feel that now another gospel is needed. The specialist has won his spurs. The value of research is recognized by all, by business men and politicians as well as educators, both for its contributions to knowledge and as a means of mental training. The Ph.D. degree is quoted above par in every list of academic stock. A graduate course is a sound investment.

Specialization has not been carried too far. The only fault to be found with the specialists is their disposition to insist upon making their efficient method of research the exclusive method of education in all grades. The present partition of the sciences is the accidental result of their historical development, like the prevailing boundaries of nations. We are then not violating any law of nature when we adopt for pedagogical purposes another system for the classification of natural phenomena, when we substitute a psychological for a chronological way of approach.

But there is more to the theory of General Science than the introduction of a subdivision by subjects rather than by sciences. There is, or there should be, the synthetic point of view in contradistinction from the analytic. This is more needed than ever with the growth of specialization. The more specialists there are in medicine the greater the need for the general practitioner.

The high school teacher has the strategic position in the entire

range of education, since he has the most impressionable period from an intellectual point of view. The high school has a double function. It is a finishing school for the many and a preparatory school for the few.

But I do not think that this double duty is so much of a disadvantage as it seems, for the student of science, however far he may go, starts from the same standpoint and so needs the same beginning, that is, a preliminary survey of the field before him.

Two things I think should characterise the first course in science; it should be concrete and it should be comprehensive. It should start from where the pupil stands and it should cover a good deal of ground.

Your main object is to inculcate the scientific habit of mind which consists in constantly looking for the reasons and relations of the things you see about you. A baby in his first outlook on the world doubtless sees it in two dimensions only, a particolored patchwork of shifting shapes on a plane surface. Later he finds that he can interpret this panorama by assuming that every object has, besides the two dimensions that he can see, a third and invisible dimension sticking out behind to hold it up, like the prop on a bit of stage scenery. Later in life he discovers, or is taught, that there is more to the world than shapes and solids; that there is a principle behind it all, which he needs to know if he is to understand and control the phenomena of nature. This principle is, like the third dimension, invisible to sight and discernible by the mind's eye only. I would call it the fourth dimension of the universe if Einstein had not already appropriated the fourth dimension for other purposes.

The perception of this hidden principle in all things, call it reason, law, logos, what you will, is science, and the quest of it is scientific research. The object of the quest is the unification of diversity, the solution of the old problem of the One in the Many. It is an alchemical search for the universal solvent of all questions. The problem is to find the greatest common factor of everything in the world.

The lucky thing about this for the teacher is that the material for this quest, for practice in scientific research, is to be found everywhere and free. Natural law is all-pervasive and to be discovered in everything if we know how to look for it. Books and apparatus are merely aids in the search. They are like the dumb-bells and parallel bars of the gymnasium, convenient but you can get just as much exercise without them.

You can, therefore, begin your scientific study with whatever is handy and go as far as you like. There used to be an old story of a farmer who in advertising his farm for sale called attention to the peculiar advantage of its central situation. "You can start from my farm," he said, "and go anywhere in the world." In every city we visit in the land we find that the board of trade or realtors issue a map, looking unpleasantly like a spider web, with lines radiating in all directions to other towns and proving that this particular city is really the focus of the country. The funny thing about it is that all these maps are true. According to the theory of relativity the place where you stand, wherever you may be, is the central point of the universe—for you. This is what we have always felt but we have not had it mathematically proved before.

So the choice of material for scientific study is merely to find what is most convenient to handle and will disclose its secret principle most easily. But the study has another aim than training in the scientific method and knowledge of the most important scientific laws. This is the acquisition of useful information. General science tries to kill these two birds with one stone and this disturbs its aim a bit. You will see by comparing textbooks that authors differ as to the relative importance of these two objectives. One will curtail the demonstration of scientific theory to give room, or rather time, for a fund of practical knowledge; another author will sacrifice everything for principle. I will not venture into this controversy, but content myself with the general observation that General Science should keep to the practical so far as practicable. The question reminds me of the discussion that arose in the White House during Lincoln's administration as to what was the proper height for a man. The dispute was referred to the President. "Mr. Lincoln, how long do you think a man's legs ought to be?" Lincoln replied that, in his opinion, a man's legs ought to be long enough to reach from his body to the ground. So I say of a science; it does not matter how high the science rises into the air, so long as it stands upon the solid ground.

But a science, like a radio set, works best when it is well grounded. The taller the antenna the better must be the grounding. Even mathematics, the most ethereal of the sciences, has grown faster since it has been set to work, although the friends of mathematics predicted that utilitarianism would be the death of it. The science could not survive such servile em-

ployment. When the higher mathematics began to be found useful in the manufacture of electrical appliances, President Patton of Princeton expressed his great regret for, said he, "as the utility of a subject increases its educational value decreases." The same position on the question was taken by Professor Wendell of Harvard, who held that "the very fact that the abstractions of mathematics must generally seem repellently lifeless, is part of the secret of their educational value." To these education authorities I may add the opinion of a more recent philosopher, Mr. Dooley of Chicago, who in reply to a question from Mr. Hennessy as to the proper content of a curriculum said: "It don't matter much what ye study, Hinnessy, so long as ye don't like it." This is the theory of formal discipline carried to its logical extreme.

I do not present these quotations in order to convert you to the idea that the chief attraction of a study is its distastefulness and that its chief value lies in its uselessness. If you were converted you would throw up your jobs from conscientious scruples for General Science is definitely committed to the utilitarian point of view, however wide may be differences of opinion as to its application.

Let us now turn from the question to the consideration of method of approach.

The study of an object may begin with analysis but it should end with synthesis. It is natural for a child to take his toys apart, but later he likes to construct things. A boy can learn a lot by taking a clock apart but he can learn more by putting the pieces together and making it run. But what good would he get if he were not given a clock at all but first shown a collection of screws, pins and springs from clocks and all other sorts of machinery to be studied as "ferrology," another collection of glass and porcelain in the department of "vitrology," and a third collection of woodwork of all kinds in the classroom of the professor of "xylology?" Could he be expected to sort these specimens out according to the machine from which they originally came and put together the clock in his mind? As a matter of fact we know that one of the chief deficiencies of our system of education is that the students do not get together what they learn in the several classrooms. They often fail to realize that all knowledge is one and all facts are correlated. And one of the reasons why they have difficulty in learning this from their teachers is because sometimes their teachers do not realize it themselves.

I hope that no one will misunderstand my remarks as an attack on specialization as a method of research. It would be perfectly proper, and very likely useful, to take out all the iron, the glass and the wooden parts of various machines and bring them together for purposes of comparison, but the man who does this should not consider his job complete until he has put everything back where he found it in the end and seen that the machines are in as good working order as when he began to dissect them. He should not leave it to his students to do the latter and harder half of his job.

Science consists largely in showing relationships, not merely relationships of like materials or parts, but still more the relationship of unlike parts to one another, in the working machine or living creature. I fear that some lose sight of the organism in their study of the organs. In the case of living beings the whole is not equal to the sum of its parts. It is much greater, and to find out wherein lies this unexplained increment of the integration is the chief task of the biologist.

To preach the unity of nature is the gospel meeded at the present day. It would be well if there were injected into modern science something corresponding to the spirit of fierce monotheism that the Jew and Mohammedan injected into theology, to counteract the tendency of the specialist to set up his own ology as an independent god and make all the other ologies bow down to it. Here is the opportunity of the teacher of science. In the high school you have fresh brains which have not yet been partitioned off into the idea-tight compartments for segregation of the several sciences. You have a chance to give your young men and women a vision of the promised land from a Pisgah peak before it has been divided up among the twelve jealous tribes.

It is often said that a unified view of the universe, that is to say, a philosophy of nature, has now become impossible owing to the vast accumulation of facts material by a century of research. But I do not believe that that is the difficulty. I think it is more that philosophy has gone out of fashion. It is true that no man can even read all the literature of a single science. He can carry in his mind only a small and decreasing fraction of the data. But, on the other hand, new generalizations are continually being discovered that embrace wider ranges of phenomena, and so relieve the mind of its burden of detail. A high school textbook of chemistry or physics which can be read in a

few hours contains a greater amount of reliable information than all the volumes in existence a hundred years ago. The task of becoming master of universology is easier now than it ever was, but the desire is lacking.

I can best illustrate my point by reference to two popular books that recently appeared, "The Outline of History," and "The Outline of Science." The history was the work of one man, H. G. Wells, and whatever the professional historians may say, it certainly met a long unfelt want of the public by presenting in readable form a complete and up-to-date conspectus of the history of the world from the solidification of the earth's crust to the downfall of the German Empire. It reflected the tastes and prejudices of the author but it had the inestimable advantage of a unitary point of view. It derived its force from the fact that it had poured entire through the narrow channel of one man's skull.

But when the publishers wanted a companion piece to cover the field of science in similar fashion they could not find anywhere an author to write it. The best they could do was to get a professor of biology to edit the work, writing such of the chapters as he felt competent to do and calling in a dozen experts to do the rest. The result is a useful book, but not so interesting as those Professor Thomson has written by himself, for it lacks coherence and continuity.

I have asked various people why some single scientist did not write the "Outline of Science" and they have invariably replied that it was because no person could so completely master the field of science as he could the field of history. But I do not believe it. I fancy that if you would heap up all the books on history extant, beside all the books on science in the world, that the history pile would overtop the science pile. And the history pile would be much more difficult to master than the science because history is still mostly a mass of miscellaneous statements, not so carefully verified and hardly correlated at all. I believe an outline of science could be written by one author. I believe Wells could have done it. I think quite likely he will sometime. He probably could do it with less trouble than the "Outline of History" for he was trained in science under Huxley, but had no such schooling in history. Whether the scientists would greet a one-man "Outline of Science" any more cordially than the historians greeted Wells' "Outline of History" may be doubted.

In the old fashioned New England college out of which our

universities were hatched, it was the custom for the president to take the seniors in hand and give them a course in metaphysics and philosophy with the aim of weaving together into a firm fabric the several threads which had been spun in the various classrooms during the four year course. The custom has fallen into disuse, perhaps because the modern university president is more apt to be an expert in politics or finance than in theology and metaphysics. Yet it seemed to serve a useful purpose by securing a certain perspective, in the point of view and by unifying the curriculum. My criticism of it would be that the perspective or orientation course should be placed at the beginning of the college work, or earlier, instead of at the end of it. My opinion is confirmed by the fact that many colleges are now introducing such survey courses into the freshmen year, for history, or natural science, or both. These courses are in the formative period and often suffer from the same fault that has been found with the General Science, that is that the course consists of a congeries of selections from the several science, not a unification of them all. This is due chiefly to the lack of teachers with the unitary point of view. In some institutions the unity of the course is confined to the common name and hour for no one man can be found in the faculty capable of giving it. So the professors from the various departments take turns onthe platform, and each displays his electives before the prospective investors, paying no attention to his colleagues except so far as necessary to demonstrate the superiority of his own wares. Yet the introduction of such fundamental orientation course is, in my opinion, one of the greatest advances in college education of the current decade, and I believe that it will eventually develop a new system of natural philosophy and sociology that will incorporate and unify the vast mass of scientific and historical facts that have been unearthed by the energetic research of the past hundred years.

A similar generalizing and synthesizing course of a more elementary character seems to be needed in the first year of the high school. The modern high school corresponds more nearly to the old college than does the modern university. Many of your students are as old as the college graduates of the last century whether their age is measured by years or intelligence tests. They are at the age when they take more interest in generalization than at any other period. The thoughts of youth are long, long thoughts. This is the time of the hasty adoption

and ardent advocacy of strange theories. He catches a glimpse of truth in some novel notion and takes it as the key to all the problems of the universe. This is the time when, if ever, original ideas are most apt to spring into his brain. His unstable mind wanders about like a spider seeking for a point of attachment on which to spin its web and woe to him if it becomes attached to weak and inadequate foundation. This is the time when a casual remark from a teacher may fix a philosophy for life.

SUPERVISED STUDY IN THE SCIENCE GROUP.

By C. O. Duncan,

Springwells Unit Schools, Louis and Michigan Ave., Detroit, Mich.

Supervised study may well be applied to the science group; and that group is in as much need of a new method of presentation as any of the subjects now given in our secondary schools. To realize the truth of this statement one needs but to enter into discourse with a man in the University of Michigan who, for several years, has been dealing with the products of our secondary schools. He will tell you that in most cases the fundamentals are fixed in the students' minds in an erroneous manner, and that it is very difficult—sometimes impossible—of get the student to right these wrong impressions. Now, what are the reasons for these wrong impressions? It seems to me that the chief cause is the formal definition method of dealing with the work. That is, in many cases we find the definitions and tormal statements presented and problems worked by students, and the students seem to be accomplishing something; while in reality we really have a cook book method of doing the work. Now the cook book method in science will be a hard one to get away from when a teacher has become accustomed to it. I think that supervised study may be a method that will help us considerably in getting the basis for our principles as well as the principles.

First, let us consider general science. This subject is an innovation in our schools, and, consequently, is in an experimental stage. I should like to relate a method which, in itself, is very simple, but which, I believe, shows the value of supervised study. The method might, no doubt, be called directed study, but the results—when it was tried—were quite pleasing. I attempted to give the students thirty minutes to study on the next day's lesson. At least half of the time alloted to recitation (or the first part of the period) I spent doing experiments which were

called for by the text, the students observing and explaining as the experiments proceeded. Then, during the second half of the period, I had the students write a summary of the experiments, not from the book but from remembrance. Now strange to say very few of the students remembered all the facts and explanations that had been given at the time the experiment was explained. Now, suppose these questions should arise outside the class room—and those conditions do arise in the case of the student who is absent, and does not make a particular effort to make up his work—how would the student find the facts? It appears that there are two alternatives here; the student can either look for the facts in his text or he can let them go unanswered. What is gained by deriving the answers to experiments from texts? Very little if the main purpose of finding the principle is merely to be able to write it down in some note book.

But if the student is in the room where the experiments were performed and has questions, he may answer them to some extent by examining the apparatus and chemicals used. Then, as to the principle of them, it will be up to the teacher to see that he gets it. The teacher can be examining the work as it progresses, and, at points where the student does not seem to be clear on the matter the teacher can present other parallel cases, until, finally, it will dawn on the pupil just for what the experiment has been. I think that if the teacher is alert he will see when the pupil is beginning to get the wrong conception of a subject, and will then attempt to set him to work along the right line of thought.

The teacher, by supervised study in science, can conserve time for the pupil. How many of us have not spent hours in working science problems and writing experiments that have been completely wrong? At least, the students' time is valuable enough to have it directed in the right manner. This does not mean that we are not to let the student do his own thinking; but it does mean that when he has drawn erroneous conclusions we should see that those conclusions are righted at the soonest possible moment. I think it well to make a statement at this time that would serve as good philosophy for our teachers; and that statement is that our schools are for boys and girls, and not for the purpose of furnishing school teachers with jobs. I think we often lose sight of this important fact.

In general science the supervised period is much to be preferred to the socialized period. With the present day type of news

paper, which prints every freak idea with which it comes in contact, we find that the student is continually bringing up these various subjects for discussion; and, in many cases our unwillingness to deal with these topics is interpreted by him as a confession on our part, of not being thoroughly competent.

Now supervised study does not completely do away with this evil; but it will do much to lessen it. If you spend the recitation portion of your period doing experiments which illustrate principles, and then have drill on these principles and summaries of principles written, it is not necessary to have discussion to "kill" time; but you can devote the period to constructive work on new principles. The group of people I was dealing with in general science were the eighth grade. Our school was in a state of transition, with no definite length of periods such as we find in the settled school. I was fortunate enough to have a fifty-five minute period for science; and I apportioned the time in the following manner: I took about twenty-five minutes for demonstration and recitation, about ten minutes for discussion of future work, and the balance of the time for study. Now, at times it happened that a demonstration took the full period; but in most cases the demonstration took only a short time and could be performed easily in the allotted time. Especially is this true if the teacher has planned the experiment and tried it before hand.

As to the value of supervised study, I had a chance to see the difference between a group having supervision, and one not having that advantage. I had the same group of students for work in civil government, but the period was shortened to thirty-five minutes in the clear. We had little time for class study. The class was provided with a study period but I was not in charge. The general standard of the class was noticeably lower than that of general science; and, at times, I was undecided as to the value they were getting from the course in civil government. They simply did not accomplish as much in the one course as they did in the other. One boy in particular, that I recall, was apparently a fairly intelligent person. In science, by seeing that he was started on the right path, I succeeded in getting him to have a fair idea of what the course was about; but in the civics course I could not get him to show any spark of knowledge at all. This difference may not have been due solely to supervised study in the science course but I have a satisfied feeling that it was partially due to that at least, and I, for one am planning to use super-

vised study wherever I can get time to do so. I must say that the trouble I did have with the eighth grade was that they seemed to like to spend the period in preparation for the next period class; but, on application of certain disciplinary action on my part, they soon became accustomed to the procedure, and all worked well.

I do not see why we cannot incorporate supervised study in science courses where we have considerable individual laboratory work. I cannot conceive of a laboratory course serving its real purpose unless we do incorporate these ideas of supervised study. We can have two types of laboratory instruction, directed and supervised. In a biology class, for example, considerable time is spent in laboratory work; and whether or not the student sees anything in the lesson will depend on the extent he has been led to see it. H. V. Porter, in his report on supervised study, points out the advantages of such supervision in general; and, as applied to biology tells how a double period may be used for class study. Much time was saved by dispensing with test questions to detect whether the student has studied or not. If you have the student work in the laboratory or in the class room you can tell how much he is accomplishing by observing him. To allow for individual differences, Porter had a range of references, and he let his brilliant pupils read the more technical books on the subjects under discussion.

In applying supervised study to chemistry and physics I find there is more of a problem for the teacher to solve in order to properly confine the demonstrations and recitations to the first part of the period. It seems that the subject matter of these sciences is so broad that it is impossible to adequately cover the material in the alloted time; but it seems also to be true that the way to get satisfactory results is still to be found. Undoubtedly, if we should exercise more care in selecting the content of our course, and then apply principles of supervised study for half of each period, we should have more material retained by our students than we do at the present time.

We hear much talk about using the inductive method in science, and we go far to show how this is the only method by which we can hope for pleasant and profitable results from our science teaching. Let us take a case of inductive reasoning called for in establishing the various laws of combining proportions which are some of the fundamental laws of chemistry, and see how supervised study can help us in this case. From the nature

of the study, we will take some substance as mercuric oxide and heat it, thus obtaining metallic mercury and oxygen. By doing several samples and weighing the amounts in each case, the pupil will observe a certain definiteness there. For another example we might take water and hydrogen dioxide, and show that there is twice as much oxygen in the latter as in the former. Then we may still take another example, as sulfur dioxide and sulfur trioxide, the latter containing one more atom of oxygen than the former, but the sulfur dioxide contained two atoms of oxygen which was twice as much as we found in water. Now, in the above, we have examples enough to establish a law—namely, the law of definite proportions.

Most chemistry teachers of experience, however, tell us that the student is not yet ready for the law, nor will he be until he has become familiar with many more examples. The idea is that the pupil is to study these examples, and is to find more pairs of such compounds, until, in his own mind, he sees that there is a definite proportion that is expressed in terms of small whole numbers. Under the formal presentation method of instruction we should expect to have every student consider every example that every other student does; and we should try to bring the whole class up to a realization at the same time and moment that there was this principle of definite proportions. Now, just as certainly as the class is made up of different individuals, just so certain are you that not all the group are not going to grasp this law at the same time, using inductive reasoning. Either some of the students are going to lose out or some method of dealing with the individual must be devised.

I think that this is where supervised study comes in. During the first part of the class period you may have your interchange of ideas, and your recitations over the previous assignment. Then, in giving your new assignment, you can point out the method to be used in studying the group of elements or compounds, after which your pupils may begin their study. Supervise with considerable individual questioning, until students, each one for himself, has deduced the law.

Let us consider another common problem found in chemistry, that of equation writing. Here we have a case some what similar to a problem in algebra. For example, in writing oxidation and reduction equations the teacher must first explain the terms as used in connection with equation writing. Then he can point out that the subscript for the number of molecules of

oxidising agent to be taken is found by finding the change in the oxidation number of the reducing agent. Then he may attempt to represent this by an equation. Undoubtedly he will give a number of such equations to balance. Under the old system John Jones would get the idea, and work his equations all right. All of John's friends would also have their problems but, curiously enough, would not be able to apply the principle when asked to do so. The reason of course is obvious. Under supervised study John Jones will have his equations before he leaves the class. Of his friends some of them will have one equation finished, others will have more than one. The one thing, however, that the teacher can be fairly sure of is that every one understands how to apply the important principle used in writing oxidation and reduction equations, for he will have an opportunity to show his pupils where they are making their errors. He will thus be able to help the type of student who can follow an explanation, but cannot seem to get started when he must work by himself. In this way the principles are mastered when they should be, and the pupils are not allowed to drag along without understanding them, as would otherwise be the case.

Now, when we come to consider the problem of laboratory work in chemistry and physics, it is advocated that a sixty-minute period would work more efficiently than a double period, the saving of time being made by having the student realize that he has work enough to keep him busy every moment. On the other hand, when the double period is used he comes to class with the notion that he has lots of time and proceeds accordingly.

Yet, whether the double or the single period is used, very little real work is accomplished unless the teacher takes real interest in seeing that every student is proceeding along the plan of the experiment. A brief quiz for each student will bring to light any existing fallacies, and will thus show the teacher where each particular student needs assistance.

There is no doubt that very careful supervision is needed in laboratory work. At the present time I am assisting in the qualitative analysis department of the University, and it is apparent even in the case of university students, that many have not acquired the elemental methods of ordinary chemical manipulations. Evidently they have been given directions in earlier courses, but no one has really supervised them to see that they acquire correct habits. Now they have a handicap to overcome

—a handicap that seriously interferes with their progress. Under a system of true supervision this sort of thing would be overcome.

I believe that I have shown—at least I am convinced—that supervised study has a place in the sciences. In a very limited way, I have attempted to place before you a general outline of the way I should attempt to handle supervised study in the science group.

THE REVIEW IN PHYSICS—THEORY vs. PRACTICE.

By John Anderson,
High School, Ford City, Pa.

The professional literature which sets forth the theory underlying the review lesson and the practices of physics teachers herein reported both seem to justify four fundamental purposes of the review lesson. Although it is impossible to assign relative values to each of these purposes without specific knowledge of the given class and subject matter, they are here listed in what is probably the order of decreasing importance.

A. Perspective.—It should be the aim of the review lesson to set aside minor details, necessary in the process of learning, and to emphasize essential principles. The student in being induced to look upon the material from a different point of view will be likely to view the various items in more useful relationships than during his first progress through the subject. A certain teacher reports that upon completing the study of electricity the class investigated the electrical power plant of the borough. The project included a survey of the generating machinery, the distribution through the borough, with some computations of power, costs, etc. This project covering five days' work served as review.

B. Summary.—The material studied should be organized and summarized so that the subject matter will exist before the pupil as an organized whole. After covering the subject of light, a class was required to prepare a topical outline as the next assignment. During the next class period the teacher and pupils co-operatively formulated an outline which was placed on the board. Mimeograph copies of the outline were then made and distributed.

C. Make up.—The review offers a final opportunity for students to master material which they have failed to master

through absence or other causes. During the study of sound many students were absent from a certain class on account of illness. Rather than repeat the first process of going over the subject matter, the teacher furnished the pupils with copies of searching questions and exercises covering the whole unit. The answering of these necessitated comprehensive study on the part of those who had been absent, and challenged the best efforts of those who had been present.

D. Testing—Using review for locating and correcting deficiencies should be considered of minor importance. The review procedure is decidedly better adapted to new learning that it is adapted to measuring what has already been learned. It is true, however, that in serving the three functions above, it does to some extent measure both the pupil's accomplishment and the success of the teaching methods employed. When deficiencies are thus discovered, the obvious remedies may be supplied.

In order that the review may function properly, both the organization of the course and the construction and administration of the review lesson must meet certain criteria, of which the following are essential. Unless each of these questions can be answered in the affirmative with regard to any particular review procedure, it is probable that the procedure is to that extent out of harmony with the consensus of expert opinion.

1. Is the course of study organized in subject matter units rather than in time units? (i. e. is the subject organized as mechanics, heat, sound, etc., rather than as material studied so many periods?)
2. Is the review conducted at the completion of a unit of subject matter rather than at the end of a time interval?
3. Is the review lesson so organized as best to
   a. Accomplish the fundamental purposes as given?
   b. Require a "new view" instead of repetition?
   c. Challenge the pupils best efforts by placing the burden of the work upon the pupil rather than upon the teacher?
   d. Give specific and clear directions as to how the pupil should proceed?
   e. Secure motivation by offering a new approach to old material in order to give it new interest?
   f. Emphasize essentials and subordinate details?
4. Is sufficient time allowed for the review?
5. Is the review followed by an examination from which no pupils are excused?
6. Does the examination function to organize knowledge and emphasize essentials?
7. Is the type of examination used adapted to the particular purpose of the review?

The summarized returns from fifty teachers of physics are so arranged as to facilitate comparison with the criteria.

1. Thirty-five teachers have organized their courses into subject matter units, fifteen into time units.

2. Seventeen conduct reviews when the school calendar calls for marking of pupils, thirty-three upon the completion of a unit of study.

3. No attempt is made to evaluate or classify the methods of review commonly employed since the merits of any method depend so largely upon their application and administration. Teachers were requested to mark the type most commonly used (1), the type next most commonly used (2) and so on in descending order of frequency of use. The rating was determined by dividing the sum of the ranks assigned to each item by the number of times rated. A low rating therefore means high frequency.

Review methods listed in order of decreasing frequency of use by fifty teachers reporting.

		No. of Teachers	Rating
(1)	Oral review of text material	45	1.58
(2)	Answering questions at close of chapter	38	2.55
(3)	Using outlines prepared by teacher	20	3.2
(4)	Use of syllabus questions such as Regents College entrance examinations, etc.	24	3.21
(5)	Teacher using recitation period to form outlines with pupils	17	3.47
(6)	Requiring students to submit lists of questions	23	3.52
(7)	Individual reports on topics covered	27	3.59
(8)	Informational tests—alternate response completion, matching, et al.	19	4.00
(9)	Topical outlines drawn up by pupils	9	4.55
(10)	Visits to machine shops, factories, etc.	26	4.84
(11)	Use of lantern slides or reels	13	6.07

4. The average time spent on review during the entire course is thirteen and one-half class periods. Fourteen teachers use less than ten class periods.

5. The test value alone was cited by ten teachers as the function of review. Apparently the review has been construed as a measuring procedure.

6. Five indicate that they do not usually follow up the review with an examination and, of thirty-two reporting on exemptions, nineteen allow some form of exemption.

7. The types of examination reported in use are listed below.

	Types of Tests	*No. of Teachers Using*
(1)	Specific fact	30
(2)	Completion	23
(3)	Oral quiz	21
(4)	Alternate response	19
(5)	Laboratory	17
(6)	Multiple choice	12
(7)	Non-limited response (essay)	7
(8)	Limited response	6
(9)	Matching	5

Returns to the question blank as interpreted by interviews indicate wide discrepancies between the theory and the practice of review procedures. In accounting for such we might profitably consider such questions as the following:

1. Are the recommendations of professional literature dealing with the review impracticable, unsound, or both?
2. Are teachers acquainted with the recommendations?
3. Are there administrative difficulties? Do examination schedules, exemption rulings, and similar commonplace obstacles prevent the legitimate use of review?

MATHEMATICS IN THE JUNIOR AND SENIOR HIGH SCHOOLS.[1]

By Marie Gugle.

Assistant Superintendent of Schools, Columbus, Ohio.

This topic, as assigned, is a very large one to be covered in the allotted twenty minutes. Its discussion must necessarily be limited to a brief outline of the tendencies in mathematics teaching.

All teachers of mathematics in this group fully understand what the reorganization of mathematics means. I take it, however, since this subject was placed on a general program, that the purpose was to let our colleagues, the teachers of science, understand what is going on in our department.

As teachers of mathematics in secondary schools and colleges, even we may not be as familiar as we might be with the changes that have been effected in the teaching of arithmetic in the grades.

Arithmetic was long known as the hardest study in the elementary school. Many parents have said, "My boy is just like me. I never could get arithmetic and he can't either. I don't suppose he ever will." And they were content.

Teachers, too, found it their most difficult subject, for candidates for elementary teachers' certificates usually made their lowest grade in arithmetic. With such a combination of attitudes on the part of parents and teachers, what chance did the subject have?

Within the last decade or two has come a marked and almost universal improvement in grade teaching, as a result of the studies in psychology and in the learning and teaching processes The minimum essentials in the fundamentals of arithmetic have been established. Little children are taught to reach a definite standard of skill in manipulation of simple integers and fractions. Fractions with absurdly large denominators are not now given them to their confusion.

A grade teacher no longer says, "Jimmie can't do division." She has learned to diagnose Jimmie's particular difficulties in division and to apply remedial measures. She diagnoses his difficulties in solving problems and definitely trains him in methods of attaching and analysing them.

The result of this study and improvement in the elementary field is a more definite standard of achievement in arithmetic

[1]Read before the general session of the C. A. S. and M. T. at Senn High School, Chicago November 28, 1924.

by the end of the sixth grade and a better knowledge and more usable skill on the part of the pupils. It means that secondary teachers have a more fixed and secure foundation on which to build.

In these two decades what have the secondary teachers been doing? The Central Association has been active, in co-operation with such other agencies as the National Education Association, the National Council of Education, and the Mathematical Association of America, in furthering this reform movement. Almost twenty years ago, this Association started a committee to search for real problems; another, a little later, to standardize terms and symbols in mathematics.

In 1916, it joined with other groups in forming the National Committee on Mathematical Requirements, whose epoch-making report was published in 1923, although partial preliminary reports had been issued as early as 1920.

Simultaneously, there was a movement spreading among administrators that has proved a great help to the mathematics reform, namely the Junior High School movement. This administrative unit, as you know, comprises the two upper grades of the old 8-4 system and the first year of the high school. These are the three grades in which most pupils became discouraged and failed or left school. Business men were bitterly criticizing the product of the public school. Modern psychologists were exploding the theory of mental discipline that for centuries had held the old type of mathematics in its place. Recently, too, the war had taught us not only the great need for real mathematics but also our great waste of time in our methods of teaching it. So, both from within and without, great pressure toward reform was brought to bear. Mathematics teachers had to face the issue and reorganize the subject matter and adapt its methods to meet modern conditions and needs. With the ever increasing demands upon the public schools, with the unprecedented influx of the heterogeneous masses into the secondary schools, we had to break with tradition and formalism and learn to justify everything we teach and how we teach it.

Since the greatest need for reform was in grades seven, eight, and nine, the most marked changes are recommended by the National Committee for these grades. Instead of the old logical organization which completed advanced arithmetic in grades seven and eight and then took up the formal symbolism

of algebra in grade nine, a better psychological plan has been recommended. It is called general mathematics.

Some senior high school and college teachers, who are too strongly bound by the chains of tradition, fear that it is so general that the pupil will learn nothing specific. That is a very false notion. A better name would be real mathematics; for, if the material is properly presented, the pupil learns more real mathematics than was possible in the old plan; he learns it in a unified, meaningful way, as it is applied in real life around him.

One of the greatest blunders has been to assume that this general mathematics is all right for the dullard, the manual arts pupil, or the one who leaves school early, but not for the college preparatory pupil, who must be well grounded in the fundamentals of algebra.

Yet, isn't it true that this reform movement started because the old arithmetic and algebra did not give satisfactory ground work for the college preparatory pupil? We used to ask the eighth grade pupil to solve problems, to understand which he needed greater maturity and experience. We asked him to solve certain problems by long, intricate arithmetic processes and refused to give him the simple equation as a handy tool, because that belonged to ninth grade algebra.

We used to ask the ninth grade pupil to plunge directly into the complicated manipulation of symbols, which meant nothing to him, and then wondered why he couldn't use these symbols later in the physics, chemistry, or geometry class. The answer is easy. The symbols did not symbolize.

If, in the seventh and eighth grades, we introduce symbols gradually and give them a meaning, he will find them convenient tools and want to use them. By using intuitive geometry in their introduction, we set up real situations which have several teaching values:

1. This plan uses the concrete to develop the abstract.
2. It creates a feeling of need for learning.
3. It injects action into the learning, which makes it far more effective.

This plan gives time in the ninth grade to more real, useful mathematics than was possible under the old plan.

The National Committee makes definite recommendations for certain eliminations and substitutions.

Among the obsolete topics to be eliminated, including those that are of no value in business or in the further study of applied mathematics, are the following:

Fractions with unusual denominators.
Partial payments.
Artificial problems, as clock, cistern, digging, and digit problems.
Extended number of methods of computing interest.
Nests of parentheses.
Multiplication and division of long polynomials.
Tables of weights and measures, which have limited application, as troy and apothecaries' tables.
Overly complicated complex fractions.

Among the topics to be eliminated from the junior high school course because they are far beyond the comprehension of pupils in these grades are the following:

Complicated cases of factoring.
Stocks and bonds, except elementary notions thereof, as in liberty bonds.
Literal exponents.
Complicated radicals.
Systems of equations with more than two unknowns.

Among the topics, recommended as substitutes for these eliminations, as being of superior and more practical interest and value are the following:

Graphs, used as a means of illuminating other mathematics.
Interest tables, which bankers use.
Rapid calculation and short cuts with time tests.
Simple non-technical bookkeeping, with personal and household accounts and budgets, the most universally needed phase of arithmetic.
Intuitive or observational geometry, including constructions, similar figures and practical measurements in and out of doors.
(This work is vitalized mensuration. The unvitalized mensuration has always been considered a part of eighth grade arithmetic. The intuitive geometry is interesting, practical, concrete, and is the best means for teaching algebraic symbols effectively.)

Other suggested substitutes include:

Introduction to numerical trigonometry and logarithms, phases of mathematics that have a large appeal to pupils. Brief introduction to demonstrative geometry, not as a substitute for the tenth grade course, but enough to let pupils know what it is all about.
Historical sketches of men and symbols, to add interest and appreciation.

That these eliminations and substitutions strengthen the course in mathematics is axiomatic.

Reform in mathematics can not come from such a committee report alone, helpful though it be. Teachers are always the interpreters of courses of study and text books. Upon them individually depends the extent to which any teaching reform can go. They must cease using recitations for mere testing of assigned lessons learned. Instead, they must use them as real laboratories. Teachers must be keen diagnosticians, and learn to use proper remedial measures for specific troubles.

The Junior High School Mathematics chart shows graphically

not only the large topics of the various phases of mathematics that are included in a junior high school course, but also their distribution.

Some advocates of the old plan, who believe every pupil should master Ray's Higher Arithmetic before he is permitted to use a simple formula in algebra, fear that the introduction of intuitive geometry and algebra below the ninth grade is done at the expense of a thorough knowledge of arithmetic. The fact, however, is that the practice in the fundamentals of arithmetic is kept up through the ninth grade instead of being abruptly cut off at the end of the eighth. Arithmetic processes and principles are made clearer through the study of geometry and algebra, and the extended time makes for better mastery in arithmetic. Psychologists tell us that the longer the period of time over which the learning is extended, the more thorough and fixed it is.

The United States is the only country in the world where teachers have attempted to teach geometry in one year. It cannot be done and done right. Measurement, or geometry, is just as fundamental as counting, or arithmetic. The two phases of mathematics should be taught simultaneously, the one as extensively as the other. All European schools have long followed this plan.

Arithmetic and intuitive geometry combined makes the best possible foundation for algebra and all higher mathematics. Using arithmetic only as a basis for algebra teaching is like building a house with half of the foundation gone. It is not the purpose, in giving a little demonstrative geometry in the ninth grade, to make that a substitute for the senior high school course. The only purpose is to give the pupil enough of a glimpse into that part of the elementary field that his knowledge of it may be complete, not fragmentary.

The reorganized or general mathematics in the junior high school has these advantages:

1. The extended period for the study of arithmetic, geometry, and algebra gives a more thorough understanding and more permanent knowledge and skill in each.

2. The study of each phase in the light of the other two makes more associations and applications possible; and, therefore, the greater the number of connections, the better the knowledge.

3. The study of the entire elementary field as a unit, instead of in broken, disconnected parts, makes it possible for the child to see "what it is all about." This better orientation gives a meaning and purpose to the learning.

4. The improved organization and better teaching facilitates the learning so that more real mathematics may be effectively taught within the same period.

Teachers in the junior high schools, who have been in the front rank of this reform movement, are rapidly meeting the needs of the situation. The barriers to further progress come too often from the large group of senior high school teachers who have passed their period of adjustment and adaptability. Perhaps, before reorganized mathematics can be fully established, it will be necessary to wait for a new generation of senior high school teachers, recruited from those who have been on the firing line in the junior high school. Until the senior high teachers have sufficiently open minds to accept the recommendations of the National Committee as to junior high work, how can they be expected to experiment effectively with those suggested for the senior high school itself?

The National Committee recommends for the senior high schools:

1. A reduction of the time given to a minimum course in plane geometry to ½ year, and to solid geometry to 1-3 year.
2. A course in algebra to include simple functions of one variable; equations in one, two, and three unknowns; exponents, radicals, and logarithms; arithmetic and geometric progressive; and the binomial theorem.
3. A course in trigonometry, in elementary statistics, and in elementary calculus, largely graphic.

The Committee believes that eventually "methods of organization will be perfected whereby teachers will be enabled to present much of this material more effectively in combined courses unified by one or more of such central ideas as functionality and graphic representation."

Personally, I believe that the demonstrative geometry, both plane and solid, will have to be kept in a separate course, but, after a course in intuitive geometry, demonstrative geometry should be covered in one year. Intuitive geometry fuses beautifully with both arithmetic and algebra. Demonstrative geometry, which is logic, does not fuse. Any attempt to do so spoils the logic.

But a wonderful combined course for the senior high school could be worked out including algebra, trigonometry, and the calculus, using the facts of geometry in problems and applications.

First, let us all have open minds towards every attempt at reform or reorganization in mathematics, and learn all we can about it.

Second, let us strive earnestly to improve the actual classroom instruction.

Third, let us be missionaries, carrying the light to hundreds of benighted teachers and superintendents who never heard of the Report of the National Committee on Mathematical Requirements, of School Science and Mathematics, or of the Mathematics Teacher.

Let us adopt as our creed the following truths:

We believe:

1. That reorganized mathematics means "giving to each pupil the most valuable mathematical training he is capable of receiving" in each year, regardless of whether he goes through high school and college or leaves school to go to work.
2. That the right kind of general mathematics in the junior high school is the best possible foundation for later courses in mathematics in senior high school or college, as well as for work in the shop.
3. That reorganized mathematics should be introduced in all schools in grades seven, eight, and nine, whether these grades are administered as a unit in a junior high school or as parts of the old 8-4 plan.
4. That experiments should be tried to develop further the one year of demonstrative geometry, both plane and solid, in the senior high school and the combined course as recommended by the National Committee.

WHY THE CIGARETTE IS INJURIOUS.

Few seem to know that there are eighteen poisons in the smoke of the cigarette, and realize its danger to minors and to women. The cigarette belongs in the class with other habit forming drugs to the use of which the cigarette leads. Aside from the nicotine, which is one of the most violent poisons known, is one called furfural, which is also found in moonshine whiskey and according to the *London Lance*, the highest medical authority, is fifty times as poisonous as ordinary alcohol. Furfural is the product of the combustion of glycerine, which is used for its cohesive properties and to preserve the moisture of the tobacco. The burning of the paper wrapper produces a poison called acrolein and the saltpetre introduced to make the combination burn, adds to the danger of inhalation. The incomplete combustion of the paper and filling, forms the deadly carbon monoxide. The smoke inhaled in the lungs poisons the blood, which, as it circulates through the body deteriorates to a more or less extent nearly every organ in the body. Young smokers run the risk of being stunted in their physical, and mental growth. The mental injuries are even worse than the physical as it impairs the intellect and has a demoralizing effect on the character of the young smoker. Juvenile Court Judges will testify that practically all criminals are addicted to cigarettes or other baneful drugs, which is the greatest producing cause of "moral insanity." An abuse of cigarettes, which is generally the case, weakens the organism. Upon suffering an injury or an illness, the necessary pure blood is not supplied, complications due to weakened organs occur and you are in serious danger. Many of our country's greatest men have died in this manner.

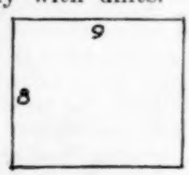
CIGARETTES ARE KILLING, INDIRECTLY, THOUSANDS OF PEOPLE EVERY YEAR.

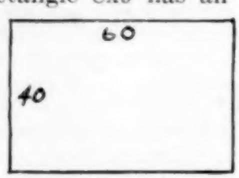
A LITTLE UNDERSTOOD PRINCIPLE IN MULTIPLICATION.

By Hilton Ira Jones and Blanche P. Jones,
Redpath Laboratories, Wilmette, Ill.

During a recent speaking tour through Oklahoma we saw at The Southwestern Teachers College at Weatherford a most unusual demonstration in rapid multiplication. This was directed by Mr. Evert J. Phillips, a senior in that institution. Mr. Phillips took students from the fifth to the eighth grade who had had from ten to fifty hours drill in his new system of multiplication and they demonstrated that they were able to multiply numbers, especially two figures by two figures, with a rapidity fully four times as great as the ordinary person can show. It made a profound impression upon us. We saw at once that it could not be their special ability, as the students were chosen indiscriminately. It must be the system. We have found that such is the case.

The system taught by Mr. Phillips was originated, we understand, by his father, Ernest Dick Phillips, who has published a small pamphlet explaining the system. In order to make plain what is actually accomplished by the Phillips System of multiplication recourse is best had to the graphic method. We feel the graph is a principle in education which should be more widely used. So simple a process as multiplication is rarely understood by the beginning student. The factors involved in the process may all be brought out with greatest clearness if multiplication is once looked upon as determining the area of a rectangle. This is sufficiently obvious if we are dealing only with units. A rectangle 8x9 has an area of 72.



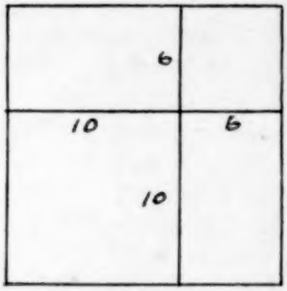


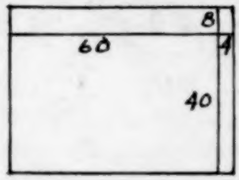
Similarly a rectangle 60x40 is simply 6 tens x 4 tens which will equal 2400.

The next simplest case would be the square of a two digit number, say 16x16. Students are taught the routine process:

$$\begin{array}{r} 16 \\ \underline{16} \\ 96 \\ \underline{16} \\ 256 \end{array}$$

But they do not understand the facts lying back of this. Inspection of the following graph makes plain that we really have four areas to obtain.





The units area is 6x6. The tens area is simply 10x10. But in addition to these we have two side strips each 6x10. These might be placed end to end which would give one strip 6x20. In other words we have simply added the tens and multiplied by the units. These four areas added together complete the area of the square:

6x6 = 36, the units square.
10x10 = 100, the tens square.
2(10x6) = 120, twice the product of the tens by the units.

256, the complete area of the square.

This is simply our first Algebraic binomial theorem, The square of the sum of two numbers is equal to the sum of their squares plus twice their product:

$$(a+b)^2 = a^2 + 2ab + b^2.$$

To this point all is very simple. Most students do not sense that all multiplication is this same process. For example 64x48 becomes:

That is we have two areas, the units area and the tens area as before. The area of these is instantly obtained by inspection. Here it is:

8x4 = 32, the units area
60x40 = 2400, the tens area

The difficult problem in such a multiplication is always the obtaining of the areas of the two side strips which represent the products of the units by the tens. This is most simply done by putting the two strips together end to end as before, that is to say, add the tens and multiply their sum by the width of the narrowest strip. Since one of the strips placed together is wider than the other one, we must add this extra area which

is simply the difference of the units multiplied by the ten accompanying the smaller unit. In this case: 60x(8−4).

This latter method is the old "cross multiplication" systeem. We usually write this so:

64	8x4 = 32, Write 2, carry 3.
48	8x6+4x4 +3 (carried above) = 67
——	Write 7, carry 6.
3072	4x6+6 (carried above) = 30.

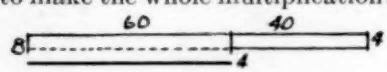
Cross multiplication works well only in case of small digits. With larger digits the cross product is difficult to obtain mentally. Cross multiplication is rarely handled successfully by children.

Note in actual multiplication what is really done.

64	64
48	48
512	32, units area
256	480, area of strip 60x8
——	160, area of strip 40x4
3072	2400, area of the tens
	3072, complete area

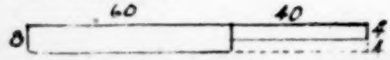
The first represents the usual process which we teach the children without any why or wherefore. This involves the carrying of the tens in every case and the setting over the product of the tens instead of writing the zero.

Now note how we may obtain the product of the units by the tens simplified so as to make the whole multiplication a mental process.



64	64	
48	48	
——	——	
3072	2,	8x4 = 32, write 2, carry 3.
	7	(6 +4)4 +(8−4)6 +3 (carried above = 67) Write 7, carry 6,
	30	4x6 = 24 +6 (carried above) = 30.
	3072	

Of course in this process of multiplying the units by the tens, that is in adding the two side strips together, it would be equally possible to multiply the sum of the tens by the larger unit instead of by the smaller one. This would be equivalent to adding two strips of the lengths given, imagining the width of both to be equal to the width of the larger, and then later subtracting from this the area of this imaginary rectangle. In our problem this would be:



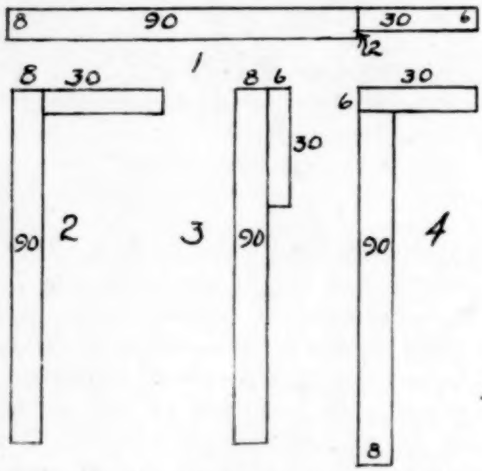
Represented in numbers this becomes:

64	
48	
2	8x4=32, write 2, carry 3.
	(4+6)8−(8−4)4+3 (carried above)=67
7	write 7 and carry 6
30	4x6+6 (carried above)=30
3072	

This is what they do in the Phillips method. That is in getting the product of the units by the tens they take the sum of the tens times the larger unit, and subtract from this the difference of the units times the ten accompanying the larger unit. The result is of course the same by both methods. But it does seem illogical and a bit confusing to add an imaginary area and then turn around and subtract it again. If there is anything gained either in simplicity or ease of operation by this process we are not able to find it. It seems to us that it actually requires greater mental effort to make part of the computation subtraction instead of having it all continuous addition, which the graph makes plain that it really is. By using continuous addition we never can fall into such a complication as Mr. Phillips describes in paragraph 11 at the bottom of page 19 of his manual.

This system enables us to multiply almost instantly all numbers up to 99x99. At first thought it may not appear that this system actually represents a saving. But any sort of an analysis of the operations involved will show that it does. In multiplying two digits by two digits, as these are usually counted, we have twenty-three operations of the eye, fifteen operations of the hand and fourteen mental operations. In this system, by the same system of computation, we have only fourteen operations of the eye, four of the hand and nine mental operations. To be sure these mental operations seem considerably more strenuous at first, but that is only because the process is new. In the practical multiplication it is not always advantageous to follow the course we have outlined, exactly. Since the product of the units by the tens is to be solved mentally it is best to keep the numbers involved as small as possible. Remember these middle figures, which constitute the product of the units by the tens, represent the areas of the side strips in our graph. Simple inspection will show that there are four

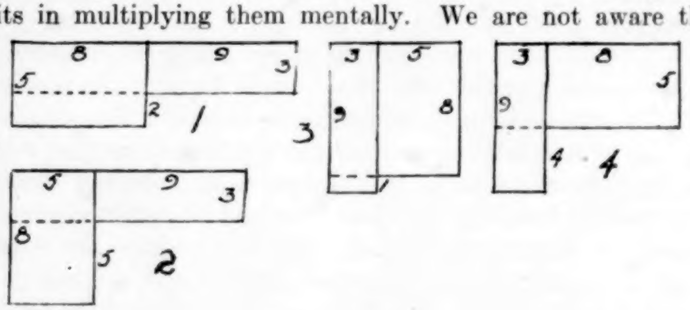
ways in which these side strips may be placed together. These are as follows; taking as an example 96x38:



This gives four ways in which we can solve for the middle figures, that is get the area of the middle strips. These are:

(1)	120x6 = 720	(2)	38x6 = 228
	90x2 = 180		84x8 = 672
	900		900
(3)	30x14 = 420	(4)	96x8 = 768
	60x8 = 480		22x6 = 132
	900		900

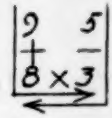
Mr. Phillips deserves great credit for calling attention in his manual to the fact that in multiplying the units by the tens the product is always a ten and consequently by setting over this product one place as in ordinary multiplication we can entirely neglect the zero digit and treat all the digits as units in multiplying them mentally. We are not aware that



any one has heretofore called attention to this fact. The following graphs will make this plain:
It will be seen that in this multiplication of the units by the tens we may use the following four groupings of the digits:

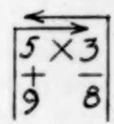
(1) 95
83

$(9+8)3+(5-3)8=67.$



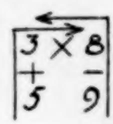
(2) 53
98

$(9+5)3+(8-3)5=67.$



(3) 38
59

$(5+3)8+(9-8)3=67.$



(4) 89
35

$(8+3)5+(9-5)3=67.$

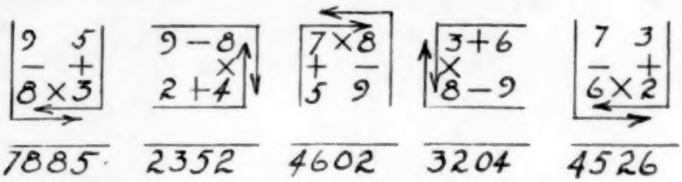
If you will write these four digits on the four corners of a square card, you will see that our squares above assume four positions as the card is rotated to the left, and that the product of the units by the tens is in each case 670, or 67, the zero being disregarded as indicated above.

The above squares make plain how by inspection we may choose the combination which gives the simplest computation. Since the difference of the digits always results in a small number, the two digits to be added should be the pair giving the smallest sum. In the above case number (3). Note also that we add one pair, multiply that sum by the smaller remaining digit, then we subtract the opposite pair from each other and multiply the difference by the digit opposite the smaller digit taken.

The speed of the actual multiplication depends upon the ability to instantly sense which pair of digits to add. It is best always to add the pair which gives the smallest sum as indicated above (3), conceive the computation as going toward the smaller opposite digit indicated by the arrow. This determines the position of the multiplication sign which remains fixed, for the other operation. Now starting at the larger digits,

subtract them, and follow the arrow again past the multiplication sign, multiplying by the digit indicated.

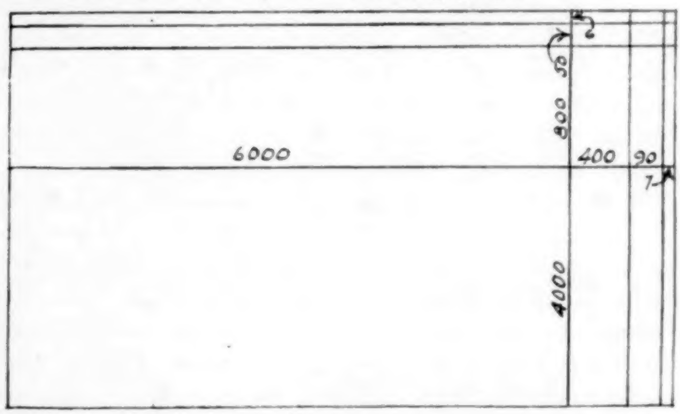
Note how this operates with any combination of figures.



If we remember that the product of any number, having 1 in the tens place, by any unit is the units digit of the product of the units, and the carried number plus the multiplier, it will assist at this point. Thus:

16	19		18	17
5	9		7	8
0	1		6	6
3	8	(the carried number)	5	5
5	9	(the multiplier)	7	8
80	171		126	136

It will be clearly seen that this often helps very much in the mental process of getting the product of the added numbers and the smaller opposite digit. So with practice the product of any two numbers having two digits each may readily be obtained mentally. And this will be employed in computing the products of numbers having a larger number of digits. This method is shown by the following graph.



In solving this we may simply group the numbers as

follows and treat each group as though it were a single digit:

6497 becomes (64) (97)
4856 becomes (48) (56)

$$\begin{array}{l}(64)-(97)\\ \quad\times\\ (48)+(56)\\ \hline\end{array}$$

5432	corresponding to the units area
3072	corresponding to the tens area
8240	corresponding to the tens by the units areas
31549432	

This process may be continued indefinitely.

THRIFT WEEK.

A nationwide campaign for success and happiness is the announced object of National Thrift Week, January 17-23 according to a statement issued by Adolph Lewisohn, Chairman of the National Thrift Committee, following the annual fall meeting of that organization, November 12.

National Thrift Week is one of the foremost annual events of this kind in so far as education and financial interests are concerned according to Mr. Lewisohn. In accordance with the custom, followed since 1916-when this movement first began, the week will open on Benjamin Frank, lin's birthday, January 17.

Saturday, January 17	Pay Bills Day.
Sunday, January 18	Share With Others Day.
Monday, January 19	Thrift or Bank Day.
Tuesday, January 20	Life Insurance Day.
Wednesday, January 21	Own Your Home Day.
Thursday, January 22	Budget Day.
Friday, January 23	Safe Investment Day.

1925 Slogan—"FOR SUCCCESS AND HAPPINESS."

Each year an increasing number of educators use Franklin's birthday as an occasion for teaching patriotism and thrift that being the only patriotic event in January. The story of Franklin, the American apostle of thrift, affords a prolific source of interesting features for school leaders in both American history and in thrift teaching. The fact that forty seven commercial and civic organizations are cooperating with the Thrift Week movement makes it comparatively easy to secure speakers for the schools from among bankers, realtors, life insurance men, ministers and others for the various days of Thrift Week.

Any teacher may secure free of cost a small calendar poster in two colors giving the daily topics of National Thrift Week and the Ten Point Creed and the folder "National Thrift Week at a Glance" which gives all the fundamental facts regarding this movement, without cost by writing the National Thrift Committee, 347 Madison Avenue, New York City.

SOME FORMULAE FOR CHECKING CORRELATION TABLES.

By J. N. Mallory,

President of Jonesboro College, Jonesboro, Arkansas.

There has been for a long time a recognized need for some means of visualizing the process of finding partial correlations and making definite the number and sequence of coefficients to be found. It is the purpose of this article to help in the quest of such means in two ways:

1. *By suggesting a convenient tabulation scheme for visualizing the necessary stages in the process.*

2. *By deriving certain formulae needed in checking the progress of the work.*

Both of these aims can be realized most easily by studying a concrete example and by supposing for the sake of argument

Correlations Sought												Influences Eliminated
Ton Teeth	Hear Teeth	Hear Ton	Nose Ton	Nose Hear	Eyes Teeth	Eyes Ton	Eyes Neas	Eyes Nose				Defects
.241	.293	.459	.257	.189	.636	.065	.052-	.911	.414		1	Nose
.245	.290	.460	.356	.207	.724					Sec. Order	2	Eyes
.243	.108	.447				-.222	-.038	-.469			3	Nose
.123			.096	-.157		-.062	.064		.582		4	Hearing
	.21		.22		.566	-.079		-.081	.439		5	Tonsils
		.414		.125	.674		.069	.018	.473		6	Teeth
.241	.004	.528									7	Eyes-Nose
.127			.165	-.240							8	Eyes-Hearing
	.205		.299		.660						9	Eyes-Tonsils
		.412	.104	.104	.70					Third Order	10	Eyes-Teeth
.262						-.166	-.194				11	Nose-Hearing
	-.010					-.204		-.448			12	Nose-Tonsils
		.432					.012	.461			13	Nose-Teeth
			.101			.058			.590		14	Hearing-Tonsils
				-.228			.068		.625		15	Hearing-Teeth
					.639			-.011	.368		16	Tonsils-Teeth
.305											17	Eyes-Nose-Hearing
	-.127										18	Eyes-Nose-Tonsils
		.494									19	Eyes-Nose-Teeth
			.153							Fourth Order	20	Eyes-Hearing-Tonsils
				-.384							21	Eyes-Hearing-Teeth
					.745						22	Eyes-Tonsils-Teeth
						-.145					23	Nose-Hearing-Tonsils
							.262				24	Teeth-Nose-Hearing
								-.303			25	Nose-Tonsils-Teeth
									.665		26	Hear.-Ton.-Teeth

TABLE I.—PARTIAL CORRELATIONS OF THE FIRST, SECOND, THIRD, AND FOURTH ORDERS. EYES, NOSE, HEARING, TEETH, AND TONSILS.

the work finished and the results tabulated as shown in Table I.

Explanation of Table I.

The coefficients in this table were derived from a study of five related physical defects, the object being to determine the degree of association between the respective pairs of defects when the influences of all others were eliminated. The associated defects are shown on the left, while the influences to be eliminated are shown at the top of the different columns. The coefficients shown in column one are the simple relations determined by Pearson's four-fold formula for association of attributes. The reader's knowledge of the formula may be assumed so far as this study is concerned. The results shown in each of the remaining columns were derived by use of Yule's formula for partial coefficients. Columns two to six contain coefficients after eliminating the influence of the single defect indicated at the top of the respective columns. These may be designated as coefficients of the second order. Columns seven to sixteen represent the third order and contain coefficients from which a pair of influences have been eliminated; seventeen to twenty-six, fourth order with three influences eliminated.

Total Number of Coefficients

One of the striking things about such a table is the large number of coefficients that must be determined. In the table above there are eighty coefficients, counting originals and partials. How could this total have been determined before solving? Analysis of the completed table will help in deriving a formula for making such a prediction. It will be observed that these eighty coefficients are distributed among the four orders as follows: 10, 30, 30, and 10 respectively. If there had been seven related items instead of five the distribution would have been 21, 105, 210, 210, 105, and 21 respectively, the proof of which will appear later. The sum of the first series with the common factor 10 removed is seen to be 10(1+3+3+1). The second factor of this product resembles the binomial series and suggests the following:

$$1+\frac{n-2}{1!}+\frac{(n-2)\,(n-3)}{2!}+\frac{(n-2)\,(n-3)\,(n-4)}{3!}.$$

The first factor suggests the following:

$$\frac{5!}{2!3!} \text{ or } \frac{n!}{2!(n-2)!}$$

This is the number of combinations of five things taken two at a time, n here, as in all other formulae to follow representing the number of related attributes. If the two factors are written together, the result is a formula that may be used for finding the total number of coefficients. It first takes the following form:

$$\frac{n(n-1)}{2!}\left(1+\frac{n-2}{1!}+\frac{(n-2)\,(n-3)}{2!}+\ldots\ldots\frac{(n-2)!^{n-2}}{(n-2)!}\right).$$

When simplified it becomes:

$$\frac{1}{2}\left(\frac{n!^{2}}{1}+\frac{n!^{3}}{1!}+\frac{n!^{4}}{2!}+\ldots\ldots\ldots\frac{n!}{(n-2)!}\right).$$

The reader should convince himself of the soundness of this formula by applying it to a few special cases. The case suggested above where n equals seven, when tested by the formula gives the following:

1/2 (42 +210+420+420+210 +42)

i. e. (21 +105 +210 +210+105+21) =672

USE OF FORMULAE IN CONSTRUCTING TABLES.

Planning the details in table construction may be simplified in advance by use of certain formulae other than the one mentioned above. Thus if it is desire to determine the number of columns and rows to be included in them, the application of the following simple formulae settles it. First, there are $(n-1)$ orders, for, if two of n things are paired, $n-2$ are left to be dealt with. These can be selected or rejected in groups varying from zero to $n-2$, i. e. in $n-1$ ways. The next question that arises is the number of columns in each of these orders. From the table they will be seen to be as follows:

$$\frac{n!}{n!},\ \frac{n!}{(n-1)!},\ \frac{n!}{2!(n-2)!},\ \frac{n!}{3!(n-3)!},\ \ldots\ldots\ \frac{n!^{n-1}}{(2!-1)!}\ \text{(last term)}$$

This series when simplified becomes:

$$1,\ n!^{1},\ \frac{n!^{2}}{2},\ \frac{n!^{3}}{6},\ \frac{n!^{4}}{24},\ \ldots\ldots\ldots\ \frac{n!^{n-1}}{2}.\ \text{(last term)}$$

The General Term is:

$$\frac{n!}{(r-1)!\ (n-r+1)!}$$

r representing the order.

For the five attributes used in this study, the total number of columns is: $1+5!^{1}+\frac{5!^{2}}{2}+\frac{5!^{3}}{6}=26$, etc.

This means that the table should contain 26 columns., v......etc.

The formula for the number of rows is less complex. In general it is $\frac{n!}{2!(n-2)!}$, or combinations of n things taken two at a time. Simplifying and substituting 5 for n:

$$\frac{n(n-1)}{2}=\frac{5+4}{2}=10.$$

Therefore 10 is the number of rows required.

It should be observed just here that it is desirable to select some definite order of writing-in the defects and to observe this order in designating the rows and columns. These should be written as shown in the table above.

FURTHER CHECKS.

From the formula given above for finding the sum total of coefficients, it will be seen that the general formula for finding the number of coefficients per order is

$$\frac{1}{2}\left(\frac{n!^{r+1}}{(r-1)!}\right)$$

This is one check that can always be applied. The number of coefficients per row is constant for any given table—eight for the table above, but in general the following will apply:

$$1,\ (n-2)!^{1},\ \frac{(n-2)^{2}}{2!},\ \frac{(n-2)!^{3}}{3!},\ \ldots\ldots\ \frac{(n-2)!^{n-2}}{(n-2)!}$$

$$\text{or } \frac{n(n-1)}{2!}\left(1+\frac{n-2}{1!}+\frac{(n-2)\,(n-3)}{2!}+\ldots\frac{(n-2)!^{n-2}}{(n-2)!}\right)\div\frac{n(n-1)}{2!}$$

This means that the total for the table is to be divided by the number of rows. The number coefficients per column is not constant throughout but only within the order. In general there are $\frac{(n-r+1)!^{2}}{2}$ coefficients in each column, if r denotes the order.

Applied to the respective orders of Table I, this formula gives:

$$\frac{n(n-1)}{2},\ \frac{(n-1)\,(n-2)}{2},\ \frac{(n-2)\,(n-3)}{2},\ \text{and } \frac{(n-3)!^{2}}{2}$$

Substituting 5 for n these give: 10, 6, 3, and 1, respectively.

The number of coefficients in each column of the last order according to this formula should always be one. Any thing to the contrary will indicate an error. All the coefficients of the last order arrange themselves diagonally across the area covered by this order. Each of these coefficients will be seen, in actual operation, to be derived by means of Yule's formula for partial correlations by substituting the three r's found in a single column of the preceding order. The derivation of .665, the last coefficient in the table, will illustrate this:

$$r=\frac{.625-(.068\times-.228)}{(1-.068^2)^{1/2}\,(1-.228^2)^{1/2}}=.665$$

If these simple facts are observed, a mistake in the final operation can hardly occur.

Summary of Formulae

Number of Columns: $1+\frac{n!^1}{1!}+\frac{n!^2}{2!}+\frac{n!^3}{3!}+\dots\dots\frac{n!^{n-1}}{2}$

Number of Rows: $\frac{n!}{2(n-2)!}=\frac{n(n-1)}{2}$

Number of Orders: $n-1$

Number of Columns per Order: $\frac{n!}{(r-1)(n-r+1)!}$

Number of Coefficients per Column: $\frac{(n-r+1)!^2}{2}$

Number of Coefficients per Row:

$$1+(n-2)!^1+\frac{(n-2)!^2}{2!}+\dots\dots\frac{(n-2)!^{n-2}}{(n-2)!}$$

Number of Coefficients per Order: $\frac{1}{2}\left(\frac{n!^{r+1}}{(r-1)!}\right)$

Number of Coefficients in the Table:

$$\frac{1}{2}\left(\frac{n!^2}{1}+\frac{n!^3}{1!}+\frac{n!^4}{2!}+\frac{n!^5}{3!}+\dots\dots\frac{n!^n}{(n-2)!}\right)$$

CANADIANS TO EXPLORE BAFFIN LAND INTERIOR.

The vast expanse of Baffin Land, north of Labrador, 200,000 square miles of icy desolation, is about to yield its secrets. The Canadian government steamer "Arctic" has landed a party of engineers in command of J. D. Soper with the object of making a complete survey of the mineral resources of this practically unknown interior. They will remain eighteen months.

F. D. Henderson of the Canadian Department of the Interior, who has returned after leaving the party, says there are indications that vast amounts of coal, iron and possibly other valuable minerals will be found.

TRADE OF THE UNITED STATES WITH LATIN AMERICA —SOME RECENT CHANGES.

II

By Bessie L. Ashton,

University of Illinois, Urbana, Ill.

The bulk of our trade with Latin America is carried on with four countries,—Cuba, Mexico, Brazil, and Argentina, which took 77 per cent of the imports from the United States to Latin America and contributed 62 per cent of the exports from that region to the United States in the year 1913-14[1] and 75 per cent and 72 per cent, respectively, in the year 1920.[2]

Cuba.

Due to the advantages of close proximity, differences of climate, and a 20 per cent tariff differential, the value of trade with Cuba excels all others. The increase, also, from pre-war to post-war years was greatest, total trade having risen from about $200,000,000 in 1913-14 to more than six times that sum in 1920, though part of the increase in value was due to inflated prices in the latter year. The chief item of import from Cuba is sugar, and the trend of trade indicates fairly well the economic condition of the sugar industry in that island. Sugar represented 75 per cent of the total export trade from that country to the United States in 1913-14 and 92 per cent in 1920. Though the amount sent to the United States in 1921 was only about ten per cent below that for 1920 the value was less than thirty per cent of the 1920 value, due to a decided slump in the price of sugar from 23½ cents in 1920 to less than two cents in 1921. The depression in the sugar market also curtailed purchases, a fact that helps to explain the drop in exports to that island. The increase in the figures for 1923 indicates recovery of the sugar industry.

Among the exports that show considerable increases from pre-war to post-war years are locomotives, freight and other cars, textiles, wheat flour, bituminous coal, eggs, lard, bacon, and condensed and evaporated milk.

In the distribution of Cuban trade among the countries of the world the United States stands first, furnishing 52.8 per cent of the imports in 1913 and receiving 80 per cent of the exports, and in 1921 sending 74 per cent and receiving 80 per cent, respectively, showing a gain in the share of Cuba's import trade at the expense of European countries.

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[1]Fiscal Year.
[2]Calendar year.

TABLE I

TRADE OF THE UNITED STATES WITH CUBA.

	Total Imports from Cuba!	Cane Sugar Imports!	Exports to Cuba
1913-14	$131,303,794	$ 98,394,782	$ 68,884,428
1920	721,693,880	668,902,103	512,208,731
1921	230,374,341	194,156,615	187,726,179
1922	267,836,803	227,257,590	127,873,185
1923	376,442,581	331,925,712	192,437,893

ARGENTINA.

From 1916 to 1921 Argentina was second in value of Latin American trade with the United States, having passed Mexico in 1915 and Brazil in 1916. The most significant thing about this trade is the marked increase in the value of exports to that country, which shows for 1921 an increase of more than 145 per cent over that for 1913-14 though nearly 50 per cent below the figures for 1920. Considerable increases in amount over the pre-war export trade are shown in locomotives, cotton cloths, tin plates, galvanized sheets and plates, wire, motion picture films, and bituminous coal.

Imports include flax-seed, which found an important market in the United States for the first time during the war, cattle hides, wool, and quebracho extract.

In the distribution of trade the United States shows a gain over pre-war years, though Great Britain has regained the lead it had before the war and Germany is striving to secure second place which it held then. In this competition depreciated exchange in foreign countries gives them the advantage over the United States.

MEXICO.

Mexico, next to Cuba since 1920 in value of trade with the United States, took 5 per cent of the total exports of the United States that year as against 1.6 per cent in 1913-14, the gain being mainly in railway and mining equipment and food products. Wheat flour shipments to Mexico in 1921 were from seven to eight times those of 1913-14; corn, twenty-five; eggs, thirteen; lard, fourteen; butter and cheese, about eight, and iron and steel products from two to ten times. The value of exports to Mexico increased from $38,748,000 in 1913-14 to $207,858,000 in 1920 and $221,854,000 in 1921, in spite of the decline of prices in the last named year. An increase in the value of locomotives from $866,054, in 1920 to $10,657,634 in 1921, and of cotton textiles of over $2,000,000, as well as increased shipments of passenger automobiles, structural iron

and steel, pipes and fittings, fuel oil, and lumber account for a large part of the total increase, and reflect the influence of more stable political conditions in recent years.

Imports from Mexico are measured very largely by oil, which formed about 64 per cent of the total in 1921. Imports of this commodity have steadily increased, their total value in 1921 being more than seven and one-half times the value of the shipments in 1913-14, or 5,260,466,000 gallons.

In the distribution of trade among the countries of the world, the United States has almost a monopoly, furnishing in 1920 three-fourths of Mexico's imports and taking more than four-fifths of its exports.

Brazil.

Our trade with Brazil is like our trade with Cuba in that one commodity forms the bulk of the imports into the United States from that country and exerts a marked influence on the rise or fall in volume and value of such trade. In 1913-14 coffee accounted for about three-fourths of our import trade with Brazil. Rubber, hides and skins, and cacao are other important items. In our export trade competition with European countries is felt, especially in iron and steel manufactures, machinery, and electrical goods. Among commodities of most importance and which show an increase over the pre-war trade are mineral oils, locomotives, and cotton cloths.

In buying from Brazil the United States stands first, taking 37 per cent of the total exports of that country in 1921. In imports into Brazil the share of the United States rose from about 16 per cent in 1913 to nearly half in 1919, while that of every European country suffered a decline. Since that time a portion of the trade lost by these countries has been regained, Great Britain again standing first in 1922, largely due to increased shipments of coal, though the United States supplied 19.8 per cent of Brazil's total imports.

West Coast Countries of South America.

Some of the most important recent phases of the trade of the United States with the countries of western South America are the increase in exports to Peru, notably cotton cloths, iron and steel and manufactures thereof, and printing paper, the increase of imports of nitrate from Chile during the war and continuing until 1921 when overstocked markets called for a reduction of shipments, and the direct shipments of tin from Bolivia to the smelters of New Jersey. Other commodities

this section contributes to the United States are copper, wool, and sheepskins from Chile, copper and raw cotton from Peru, and cacao from Ecuador, receiving in exchange cotton cloth, petroleum products, machinery, construction materials, and a great variety of small manufactured articles and foodstuffs.

North Coast Countries of South America

Of the other countries of Latin America Colombia has the most extensive trade with the United States, sending coffee, platinum, bananas, and gold to exchange for such things as textiles, barbed wire, automobiles, and lard. Exports to Venezuela and the Guianas are along the same general lines, while the imports of importance are coffee and cacao, with smaller quantities of bauxite, sugar, etc.

A study of trade statistics for the last decade indicates that during the war years and immediately after trade of the United States with Latin America profited at the expense of European countries, but by 1921 there was evidence of the relaxing of the commercial dependence of these countries on the United States and a regaining, especially by the United Kingdom, of a portion of the trade lost.

The following table shows the share of the United States in the trade of some of the South American countries in 1913, 1920, and 1921. The increase from 1913 to 1920 and the hold even during the depression of 1921 should be gratifying to American foreign trade enthusiasts.

Share of the United States in the trade of some of the South American Countries.

	1913		1920		1921	
	Imports	Exports	Imports	Exports	Imports	Exports
Country	Per cent		Per cent		Per cent	
Chile	16.7	21	30	43	27	16
Peru	28.8	33.2	55	46	28	38
Bolivia	9.3	.5	30	46	22	47
Ecuador	23.6	23.6	58	55	37	41
Colombia	28.3	55	64	76	56	70
Venezuela	38.5	28.7	50	47	57	40

COLLEGES REQUIRE WOMEN STUDENTS TO SWIM.

Swimming for women is required in twenty-two colleges and universities as a part of the students' work in college, according to *School Life*, a publication of the Department of the Interior, Bureau of Education.

Cornell University, Iowa State Agricultural College, Rockford College, Syracuse University, Cincinnati University, University of Wisconsin, Wells College, Western Reserve, and Wooster College refuse to grant a degree to a student who fails to pass a fixed swimming requirement, which may be ability to swim 50 feet, strokes in good form, swimming for two years, or swimming 120 yards and diving. The most frequent requirement, however, is swimming 50 yards.

ACHIEVEMENT IN HIGH SCHOOL CHEMISTRY—AN EXAMINATION OF SUBJECT MATTER[1]

By S. R. Powers

Teachers College, Columbia University, New York City

A significant measure of the functional value of a subject of study is the extent to which it is mastered by those who study it. If a majority fail to acquire any mastery of its contents it is clear that the subject is lacking in value for the particular group. If there are units within a body of subject matter over which comparatively few or none of those engaged in its study gain any mastery, the functional value of those units is denied. An extended experience in teaching high school chemistry suggested the need for an examination of the content of this subject which would look toward the determination of the extent to which specific items used as instructional materials are learned.

In the pursuit of this examination of subject matter, tests made up of many items were given to children in a large number of coöperating schools. These were given on each of three years just before the close of school to students who had studied chemistry throughout the year. For the most part the tests used on different years were made up of distinctly different items. An exception to this was that items for a scale were selected from the material used in 1921 and used as a scale in 1922. In all, the difficulty (or extent of mastery) of 350 test items was determined. More than 60 schools coöperated. The smallest number of students counted in determining the difficulty of any item was 418. A considerable number of the items were in tests which were taken by more than 1,200 students. The proportions of the project are indicated by Table I. This shows the number of items included in the tests which were used during each of three years; it shows the number of students counted in determining the difficulty of each item; and the number of schools that coöperated each year.[2]

In an extension of the study, tests were given to a group of students just entering the university who had studied chemistry in high school and who had elected to take additional courses in chemistry in the university. The results from testing this last group is of interest for there were in it those who had completed high school work in June before entering the university and there were others who had left high school one, two and up to 17 years

[1] Copyrighted by Teachers College Record. Reprinted by permission.

[2] A more detailed analysis of the results is printed elsewhere. Powers, S. R. A Diagnostic Study of the Subject Matter of High School Chemistry. Teachers College Contributions to Education, No. 149. 1924.

before taking the tests. Their achievement is a measure of the extent to which the knowledge of chemistry gained in high school is retained by students after they leave school and an indication of its functional value to those tested.

TABLE I.
Number of students taking and number of items in each experimental form.

	Year Given	No. of Items	Number of Students Taking	No. of Schools
Test 1	1920	95	731	20
Test 2	1920	100	634	16
Test 3	1921	77	1209	20
Test 2	1921	50	794	11
Test 2 A-1	1922	102	573	15
Test 2 A-2	1922	20	543	14
Test 3 A	1922	20	418	12
Scale Form I	1922	30	700	15
Grand Total		494		

Items duplicated in different forms	114	
Unsatisfactory items	30	144
Total items evaluated		350

An effort was made to test a wide range of abilities. There were among the 350 test items some to test ability to do each of the following:

(1) Write the name for given chemical formulas.
(2) Write the formulas of substances when the chemical name is given.
(3) Construct formulas from given radicals and their valences.
(4) Write the chemical composition of common substances.
(5) Classify elements, mixtures and compounds.
(6) Classify metallic elements according to their position in the activity series.
(7) Complete chemical equations when the left hand side of the equation is given.
(8) Write complete equations for given chemical changes.
(9) Solve numerical problems.

There were tests of knowledge of (10) definitions, (11) laboratory and commercial processes, and (12) biography.

An analysis of the results reveals the standards for evaluating the subject matter. More than 98 per cent of those still in high school know that NaOH is the formula for sodium hydroxide. Clearly there is no question of the appropriateness of this item

from the standpoint of difficulty for pupils who have studied chemistry in high school for one year. The case is not so clear for many of the items. Seventy per cent recognize the formula for sulfurous acid (H_2SO_3); 43 per cent recognize methane (CH_4); 22 per cent, potassium chlorite; and but 14 per cent recognize the formula for cream of tartar. If a standard of achievement is set at ability to recognize the formula for substances described in the textbook and used in the laboratory it is clear that the actual accomplishment is far from the standard. Of 36 formulas included in the tests the names for 17 were written correctly by less than 50 per cent of the children who took them.

To write formulas is yet more difficult than to recognize them. Of the list of substances given to write the formula, that for potassium iodide was easiest. It was written correctly by 87 per cent. Less than 50 per cent could write the formula for copper nitrate correctly and but 22 per cent could write the formula for so common a substance as silver sulfide. Of 35 items like these, the formulas for 18 were written correctly by less than 50 per cent. Only the formulas of very common and simple substances were written correctly by more than 70 per cent.

More than 700 students attempted to write the chemical name for the substance of which a number of materials are chiefly or entirely composed. Eighty-eight per cent knew the composition of table salt, 79 per cent knew charcoal, and 66 per cent knew marble. Less than 50 per cent were able to make the correct response for coal smoke, limestone, sand, gypsum and many others. In fact of 60 items of this kind 48 were answered correctly by less than 50 per cent.

Similarly there were in each of 12 groups of items a considerable number which were answered correctly by less than half of the students. Only 49 per cent were able to calculate from the formula the number of grams of water of crystallization in 250 grams of copper sulfate. Thirteen per cent were able to complete the equation for the action of copper on hot concentrated sulfuric acid. Thirty-five per cent were able to write the equation which represents the action of sodium upon water. Thirty-one per cent knew that the sensitive agent of blue print paper is a compound of iron. Eighteen per cent knew the author of the theory of ionization. Thirty-nine per cent knew that the oxygen of commerce is obtained from liquid air. Thirty-six per cent knew that silver chloride is easily soluble in ammonia. Many

teachers will find surprises in these results. There were, in fact, in the tests 177 items to which the percentage of possible responses which were correct was less than 50.

The significance of these scores may be illustrated by further analysis of the data. If an item is so difficult that it is answered incorrectly by fifty per cent or more of the entire group, how many of the less capable students will be able to do it? In order to answer this the students were grouped in quartiles on the basis of their scores on the form of the tests which had been scaled. Table II is inserted to show the per cent of students within each quartile who were able to do tasks of different degrees of difficulty correctly. The table shows that item number 20 was answered correctly by 53.6 per cent of 700 students. It shows further that 68.7 per cent of the students in the fourth quartile, 66.1 per cent of the third, 21.3 per cent of the second and 1.7 per cent of the first quartile students did this item correctly. These data point directly to the conclusion that items answered correctly by 50 per cent or less of the entire group will be answered correctly by very few indeed of those students in the lower half of the group when they are grouped according to scores on the scale. Practically, the results indicate that much of the work is adapted only to the ability levels of the best 50 per cent of the students.

TABLE II

Percentage of students from each quartile who were able to do relatively difficult tasks.[3]

	Cases	*Scale Items*.......... 20	22	25	28	29
Total........................	700	53.6	47.0	36.7	24.2	23.7
Fourth quartile....	16	68.7	71.1	75.0	43.7	81.2
Third quartile	62	66.1	73.7	66.1	32.2	26.1
Second quartile.....	87	21.3	20.2	3.4	13.5	0.0
First quartile........	57	1.7	3.5	0.0	5.2	0.0

The results from different schools furnish another indication of the functional value (or lack of functional value) of the subject matter of high school chemistry for many of those who study it. A striking observation is that there is such a wide range between the scores on the scale of the median students in different schools. The extreme range is nearly four times the P. E. of the entire distribution of 2,000 scores from all co-operating schools. A further observation is that there is little or nothing in the results to indicate that students do certain kinds of tasks with more facility than others. The test items were grouped as indicated

[3]The median and quartile scores were calculated from 700 scores. Only 222 scores are counted in Table I.

above and the per cent of the possible responses which were made correctly by the pupils in each school was computed. The rankings of the schools made on the basis of these results were remarkably uniform. If the pupils of a given school showed poor ability to write equations they also showed poor ability to solve problems and to do the items of the other divisions of the tests. Similarly, schools which ranked high on one division of the tests maintained their rank on other divisions. There was also a marked relationship between the rankings on the basis of the score of median pupils on the scale and on the basis of percentage of possible responses correct to the items of a given division.

In one of the test forms there were 10 items to test the ability to write the equations for chemical changes. In one school 90 per cent of the possible responses to these items were made correctly. In another school but 8 per cent were made correctly. One of the tests consisted of 77 items. In the school which did best on the scale 87 per cent of the possible responses to the 77 items were made correctly. In the school which did poorest on the scale but 34 per cent were made correctly. Another test consisted of 60 items. In one school 68 per cent of the possible responses to these were made correctly, in another but 15 per cent were correct.

The relationship between school enrollment in chemistry and scores on the tests is too marked to be accidental. There were 16 of the coöperating schools in which the enrollment in chemistry was less than 20. The score of the median student in 13 of these 16 schools is below that of the median student of the entire distribution (2000 cases). There were 25 schools in which the number of students enrolled in chemistry ranged from 20 to 60. In 15 of these the score of the median student was higher than the standard median. There were 14 schools in which the number of students taking chemistry was more than 60. In 8 of these the median was lower than the standard median. There was a marked tendency for the schools with small enrollment in chemistry to do poorly on the tests. Schools enrolling from 20 to 60 in chemistry usually did well. The very large schools did markedly better than the smallest schools but did not do so well as those of the middle group.

What chance is there that students in the best and poorest schools will be able to do tasks of different difficulties correctly? The answer to this question was obtained for a number of items

for which the percentage of total possible responses which were correct was between 40 and 50. Approximately 85 per cent of the possible responses to items of this difficulty were made correctly by the pupils in the two schools which did best on the scale. Only 22 per cent of the possible responses to these items were made correctly by the pupils in the two schools which did poorest on the scale. Again, there were 102 items in one form of the test; 77 of these were answered correctly by 50 per cent or more of the students in the two schools which did best on the scale. Only 18 of these were answered correctly by 50 per cent or more of the pupils in schools in which the median scale score was 88 or less. Fifty per cent of the pupils scored 88 or less and the median score in 60 per cent of the coöperating schools was 88 or less. Of the 350 test items used in this investigation 103 were answered correctly by less than 30 per cent, 136 by less than 40 per cent and 177 by less than 50 per cent. These items may be appropriate for use in the larger schools in which those who elect chemistry are for the most part looking toward college preparation. It appears, however, that items which are so difficult that they are answered correctly by 50 per cent or less mean very little to most of the pupils in more than half of the coöperating schools. The standing of some of the schools is in fact so low that it suggests the entire futility of much of the high school work which is being attempted in chemistry

Another measure of the functional value of high school chemistry is the extent to which the subject matter once mastered is retained after leaving school. The functional value of that which is forgotten cannot be very large. A test consisting of 77 items which tests seven different kinds of abilities was given to a group of 349 students just entering the University of Minnesota in the fall of 1921. All had studied chemistry in high school and had elected to take additional chemistry in the university. Nearly all were men and most of them were entering the College of Engineering. A large proportion of them had completed high school chemistry in June of 1921 and entered the university in September. For these the time interval between training in chemistry and taking the test was three months. There were others who had completed high school chemistry in June of 1920; for these the time interval was one year and three months. There were others for which the time interval was two years and more. There was a considerable number for which the time interval was five years or more. These students were grouped

according to the year during which they had studied chemistry in high school. The percentage of the possible responses which was made correctly by those of each group was then determined. The results are shown in Table III. The table shows that 72 per cent of the possible responses to the items of the first division of the test were made correctly by students still in high school. Seventy-one per cent of the possible responses were made correctly by those who had been away from instruction for three months, and 34 per cent were made correctly by those who had been away from instruction for four years or more. This division of the test tests ability to write the names of given formulas.

TABLE III

Per cent of possible responses for the entire test and for each division of Test I which were correct.

	1	2	3	4	5	6	7	Entire Test	Case
High school students	72	63	82	64	68	51	49	63	1200
Entering freshmen:									
1921	71	43	88	52	72	48	36	58	25
1920	63	29	66	34	60	25	9	40	25
1919	50	20	40	31	52	18	4	31	25
1918	46	18	38	26	56	14	3	27	21
1917 and earlier	34	10	24	14	43	6	0.6	19	17

The second division is more difficult than the first and appears to be more rapidly forgotten. This is a test of ability to write the chemical formulas to correspond with the names of substances. The third division is a test of ability to construct formulas from given radicals and their valences. This is the easiest division for those still in high school and for the 1921 and 1920 groups. The fourth division tests ability to classify metallic elements according to their position in the activity series. The fifth tests ability to classify elements, mixtures and compounds. Those who have been out of school for more than two years appear to retain more of this ability than of any other tested. This observation suggests the conclusion that this ability has the largest functional value of any of those tested. The sixth division tests ability to complete chemical equations when the left hand members of the equations are given and the seventh division tests ability to write complete equations when only the descriptions of the chemical changes are given. Each of these divisions is very difficult for students still in high school and such ability to do these items as is acquired is rapidly lost. Less than one-tenth of the possible responses to the items of the seventh division were made correctly by those who had been away from instruction for as much as one year and there was but

one response made correctly on all the papers examined of those who had been out of school for as much as four years.

Scores on the scale were computed for each of these entering students. The range between the score of the median student of the group still in high school and the median of the group which had completed chemistry in high school three months before taking the tests is nearly one P. E. on the distribution of the scores of pupils still in high school. By four years the range is more than 2 P. E. This indicates that approximately 92 per cent of those still in high school do better on the test than the median pupil of the group who had studied chemistry four years earlier and who had, after the time interval, come to the university and elected to take more chemistry. These data furnish additional evidence that much of the instructional efforts in high school chemistry are misspent for they show that those abilities, the accomplishment of which are set as objectives of instruction, are, when once acquired, rapidly forgotten.

Each of the tests of subject matter point to the conclusion that a large proportion of the content of high school chemistry is of little or no value for many who study it. Certainly there are large numbers who effect no mastery of the subject matter. It appears that there are indeed many schools in which nearly none of the students obtain any mastery of the subject matter which is presented to them. The second test shows that such mastery as is obtained is rapidly lost by forgetting when the student has left school.

In 1854 President Francis Wayland of Brown University in an address entitled, A Review of the Progress of Education in this Country During the Past Twenty-five Years, gave this characterization of the work in chemistry in secondary schools: "I have no doubt that thousands of the pupils of the somewhat advanced schools have gone through a system of chemistry supposing that they have studied that science,———, and whose whole knowledge consisted in the recollection for a few weeks of some of the terms of chemical nomenclature."[4] In the light of the facts of of this paper it seems that this statement furnishes still, three quarters of a century later, a fair definition of the educative value of chemistry for many students.

There is no escape from the conviction that there is urgent

4. Francis Wayland. A Review of the Progress of Education in this Country During the Past Twenty-five Years. Lectures delivered before the American Institute of Instruction at Providence, 1854. p. 8.

need for reorganization and it is not surprising that this is so. The history of the teaching of chemistry in high school shows that the forces which have operated to determine the present course have not in any sense been purposefully directed toward relating chemistry to the needs of those who study it. One of the main objectives of instruction in high school chemistry is college preparation. A second objective frequently stated is to give a clear idea of fundamental principles. This second objective is one which in the first place is not achieved and which in the second place would be of doubtful value for general education if it were.

The search for values for instruction in such subject matter as that surveyed in this study cannot be expected to yield large returns. The findings suggest the possibility of harmful influence. The possibility of harm is found in the fact that the subject matter which is the basis of instruction is material which many do not learn. It is material which is well adapted to give practice in failure and material which deadens the initiative. This paper reports an examination of subject matter and it shows that much of that used in high school chemistry is of little or no value to a large proportion of the students. The need is now evident for an additional study which shall be devoted to the construction of a curriculum.

Curriculum studies in science must look to larger divisions than the individual units of physics and chemistry. Some of the difficulties which students encounter are no doubt due to the fact that they are plunged rather suddenly into the manipulation of materials which are for them entirely new. An organization of the sciences so that each succeeding course is related to and built upon the preceding one will result in the inclusion of science from many fields in the earlier course. The course may be graded so that the elementary units will provide for experiences as rich as possible with scientific material and subsequent ones will build upon these earlier courses and provide increasing opportunity for practice in attacking problems by the scientific method. There is need for a curriculum study which will determine the materials which should be selected to give to students the kinds of experience, knowledge, habits, etc., which will be of largest value. In brief, such a study will look to a determination of what people need to know about science and then to its organization into teachable units appropriate for the ability levels of high school pupils.

SHALL THE DRAWING BE INKED?

By J. L. Cooprider.
Central High School, Evansville, Ind.

Part I.

The authors of a number of text-books and laboratory manuals in biology and authors of texts in methods of teaching biology give an answer to the above question, while others fail to make mention of the point. The following quotations do not give a complete review by any means of what all authors have to say concerning the subject, but in a general way they give the ideas of those authors who do express themselves on the question. Apology is hereby offered the various authors quoted below for the use of their ideas without first asking their permission, however, proper acknowledgment is given in each case.

In his instructions "To the Student" *Colton*[1] writes that drawings "should first be made in pencil. Have a medium hard pencil and keep it sharp. Avoid shading, but make outline drawings. Make the first lines faint, and then, if they suit you, that is if they conform to the thing itself, go over them again and make them heavier. When the above features are satisfactory to you as drawn in pencil, proceed to trace over the lines with ink."

In the "Introduction" by *Pratt*[2] is the following statement: "The drawings must be clear and neat; they should be more or less diagrammatic . . . and should be made with a hard lead pencil."

"Directions to the Student for Keeping Notes in Biology" by *Sharpe*[3] indicate that the student should "use a well-sharpened pencil (HHHHH) for all drawings made in the laboratory."

"The type of drawings best adapted to high school biology is a simple line drawing without shading" is the idea of *Bigelow*[4] who does not state whether that drawing should be in ink or pencil.

Hunter[5] tells the students who use his book that "a hard pencil (HHHHH) sharpened to a needlelike point should be used. Do not shade your drawings. Make each line mean something definite. We do not want *artistic sketches* so much as we want *accurate* representations of what you see."

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[1]Colton, Buel P., Practical Zoology, pp. IX-XI. [D. C. Heath Co., 1903].
[2]Pratt, Henry Sherring, A Course in Vertebrate Zoology, p. VII. [Ginn & Co., 1905].
[3]Sharpe, Richard W., A Laboratory Manual in Biology, p. 11. [American Book Co., 1911].
[4]Bigelow, Maurice A., Teacher's Manual in Biology, p. 97. [The Macmillan Co., 1912].
[5]Hunter, George William, Laboratory Problems in Civic Biology, p. 19. [American Book Co., 1916].

After securing extensive data upon drawings, *Avers*[6] points out that drawings should be simple and diagrammatic.

In an article stating how drawings should be prepared for publication *Barnes*[7] indicated that all drawings should be made in ink since this would give practice in making drawings for publication. Few high school students will ever publish drawings so this would not be a very forceful argument for finishing the drawing in ink.

Peabody and *Hunt*[8] state that "in making drawings pupils should be supplied with sharp-pointed pencils that are relatively hard. Clear outline drawings should be insisted upon and shading should as a rule not be encouraged."

Ganong[9] encourages the use of ink in his treatise "ON SCIENTIFIC, MAINLY BOTANICAL, DRAWING AND DESCRIPTIONS." Among his many suggestions he states that "a somewhat hard pencil is needed, especially for finishing the drawing, if ink is not used . . . the use of ink is made voluntary with beginners, though it is required in advanced courses . . . almost invariably, the best students, after they have once tried the ink, take to its use altogether. . . . While scientific drawing is a unit as to its aims and general methods, there are several forms of it adapted to different uses. First of all, and that which beginners will mostly use, are the simple outlines, without attempt at perspective. . . Next come the shaded drawings . . ."

In another place[10] we find that the notebook "makes the most of the pupils' interest in recording personal discoveries about living things, and guides him by easy steps from simple pencil sketches to the more elaborate pen drawings."

These are the first three "DIRECTIONS TO PUPILS" given by *Moon.*[11]

"1. Use a fairly hard, sharp pencil . . .

"2. Label all parts in ink . . .

"3. Use definite, clear lines. Do not shade drawings. Put no line on the drawing that does not mean something."

Again[12] we find that "the drawing should be made . . .

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[6]Ayers, Fred C., The Psychology of Drawing. [Warwick & York, Inc., 1916].
[7]Barnes, C. R., Botanical Gazette, 61:No. 4, pp. 337-340. [1916].
[8]Peabody and Hunt, Human Biology, p. 181, [The Macmillan Co., 1919].
[9]Ganong, William F., The Teaching Botanist, Chap. V., pp. 89-108. [The Macmillan Co., 1920].
[10]Smallwood, Reveley and Bailey, Biology for High Schools, Preface p. V. [Allyn & Bacon Co., 1920].
[11]Moon, Truman H., Laboratory Manual, p. 3. [H. Holt Co., 1922].
[12]Hargitt & Hargitt, Outlines of General Biology, Laboratory Manual , p. 18. [Lea & Febiger, 1922].

with a drawing pencil (about 3H); . . . The drawings made to accompany the work of this course should be in outline like the figures, since shading tends to obscure rather than clarify the details of the structure. . . However, it is sometimes desirable to represent the texture of a part and a shaded drawing will occasionally be necessary."

"The notebook should be neat and if possible, in ink. Drawings are better made in pencil."[13] This seems to indicate that drawings are not a part of the notebook and hence need not be neat.

A very recent book[14] gives this in its preface: "Drawings may be made carefully with a medium hard, sharp pencil. Every line should be clear and should have a significance—no general effects, as it perhaps permissible in art work."

Another recent laboratory manual[15] gives this: "Outline drawings with a hard lead pencil are recommended, and each part should be carefully labeled."

Part II.

The above opinions were not selected in preference to other opinions, but rather they were the first ones to come under the observation of the author. The above unselected authors are practically agreed (1) that in high school biology the drawings should be made in pencil and not drawn or finished in ink, and, (2) that the drawings should be simple, diagrammatic and in outline. It is not the purpose of this article to challenge either of the above statements but rather to submit some objective data bearing upon the first, the second being fairly well supported with objective evidence.[6]

The data given in the tables below were secured in the following manner. The author was given four sections (A, B, C, and D) of second semester biology students. These students were given the Chicago Group Intelligence Test at the beginning of the semester and their scores were recorded. It was found that Sections A and D had the same number of students as Sections B and C, and that the average scores made on the Intelligence Test by Sections A and D and Sections B and C were about the same; hence, Sections A and D were selected to do their drawings in pencil and Sections B and C in ink. At the end of

[13]Damon, Gordon, The Teaching of Science in Texas High Schools, p. 29. [Bulletin 136, The Dept. of Edu., State of Texas, Jan., 1922].

[14]Blount, Ralph E., Laboratory Guide and Pupils' Note Book for the Study of HEALTH, p. IV of preface. [Allyn & Bacon Co., 1924].

[15]Peters, Roswell B., A Laboratory Guide in Biology, p. 9. [The Iroquois Publishing Co., 1924].

the semester all students who had not completed the semesters work were dropped. This left 18 students in Section A; 21 in Section B; 19 in Section C; and, 16 in Section D. The scores made by these students on the Intelligence Test are given in Table 1. The average score for Sections A and D was [(44.1 +- 44.0) ÷ 2] 44.0; and for Sections B and C it was [(48.1+44.7)- ÷ 2] 46.4. Thus the average score for those sections which made their drawings in pencil was somewhat lower than that of the sections finishing their drawings in ink.

Table 1.—Scores made on the Chicago Group Intelligence Test. [Letters refer to section, *e. g.*, A1 means student 1 in the first section.]

	Score		Score		Score		Score
A1	41.5	B1	52.0	C1	35.5	D2	51.5
A2	33.0	B2	64.5	C2	37.5	D3	30.0
A3	42.5	B3	66.5	C3	65.0	D4	63.5
A4	71.5	B4	53.0	C4	43.0	D5	35.0
A5	45.5	B5	32.0	C5	57.5	D6	37.5
A6	48.5	B6	37.0	C6	45.0	D7	57.0
A7	44.0	B7	40.0	C7	38.0	D8	40.5
A8	33.0	B8	61.5	C8	41.5	D9	44.5
A10	59.0	B9	44.5	C9	40.0	D10	45.5
A11	58.0	B10	36.5	C10	37.5	D11	61.0
A12	42.0	B11	34.5	C11	52.0	D12	32.5
A13	37.5	B12	57.0	C12	39.0	D13	52.5
A14	33.5	B13	30.0	C13	45.0	D14	30.0
A15	58.0	B14	58.5	C15	53.5	D16	24.5
A17	50.0	B15	60.0	C16	53.0	D17	52.0
A18	26.0	B16	54.0	C17	38.0	D18	46.0
A19	27.0	B17	35.5	C18	30.0		
A20	43.0	B18	39.0	C19	55.5		
		B19	58.5	C20	43.0		
		B20	55.5				
		B21	37.0				
Av.	44.1		48.1		44.7		44.0

At the beginning of the semester it was planned to give as many drawing exercises as possible which could be tested objectively. At the end of the semester 17 such exercises had been given. The exercises consisted of drawings made from specimens, or from copy on the blackboard or texts. Each drawing was fully labeled and each had a note of explanation. In order to test the results, unstandardized, objective tests were devised. These consisted of from 10 to 30 points each, and in most cases each answer consisted of a single letter or word. Some tests were planned to test preparation and were given before the topic had been discussed in class; others combined preparation and discussion; and, a third group added the retention feature. In some tests the student was asked to identify plants or parts of the same; in others he named the plant, gave

Table 2.—Scores made on tests by 18 high school students who finished their drawings in biology with pencil.

Student	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15	Ex. 16	Ex. 17	Total
A1	6	0	11	3	4	9	7	4	9	14	10	4	7	8	13	12	8	129
A2	3	0	5	3	3	9	5	0	7	8	6	1	8	4	13	15	8	98
A3	3	4	3	1	1	8	3	0	1	12	6	4	9	13	9	9	8	94
A4	10	8	13	10	10	10	8	10	9	20	24	13	18	16	19	24	10	232
A5	2	3	6	7	9	7	7	1	3	8	13	4	10	7	3	10	3	103
A6	1	0	1	2	0	4	3	3	9	10	12	4	13	8	11	12	10	103
A7	5	6	7	0	6	6	5	6	8	13	8	2	9	11	10	13	7	122
A8	3	8	9	4	7	9	3	7	8	11	12	5	11	16	6	17	9	145
A10	5	6	11	4	8	7	8	3	8	8	14	3	9	12	5	22	8	141
A11	5	0	8	1	4	6	8	5	7	18	12	4	13	10	5	14	8	128
A12	3	0	5	2	2	7	4	2	8	12	11	0	14	3	3	11	9	96
A13	4	2	7	1	3	3	2	3	3	9	6	0	7	10	2	14	3	79
A14	5	4	10	2	7	9	2	5	9	10	6	2	6	16	15	17	9	134
A15	2	0	9	2	3	9	6	4	2	13	10	5	11	7	16	22	4	128
A17	7	2	8	8	9	7	8	4	7	10	13	4	13	12	8	19	6	145
A18	4	4	3	7	6	9	5	4	5	9	10	4	8	3	7	18	8	114
A19	6	4	10	5	8	6	9	5	8	17	12	5	9	11	11	12	7	145
A20	4	0	4	1	4	8	6	4	7	15	10	8	10	9	15	6	2	113
Total points..	78	51	130	63	94	133	99	70	118	220	195	72	185	176	171	267	127	2249
Aver. points	4.3	2.8	7.2	3.5	5.2	7.4	5.5	3.9	6.6	12.2	10.8	4.0	10.3	9.8	9.5	14.8	7.1	124.9
Possible pts.	10	10	13	10	10	10	10	10	10	20	30	13	20	20	20	25	10	251
%	43	28	56	35	52	74	55	39	66	61	36	31	51	49	48	59	71	50.2*

*Average of the total per cent scores.

Table 3.—Scores made on tests by 21 high school students who finished their drawings in biology with ink.

Student	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15	Ex. 16	Ex. 17	Total
B1	7	2	6	3	5	8	3	1	5	9	10	5	13	14	9	14	7	121
B2	8	10	13	10	10	7	8	8	6	13	16	3	14	13	20	17	9	185
B3	6	6	9	4	5	8	4	4	2	13	13	5	10	10	10	18	9	136
B4	4	4	6	1	5	7	1	4	8	16	13	9	10	6	16	12	5	127
B5	5	1	0	2	5	6	5	0	4	10	5	3	6	8	3	18	5	86
B6	8	7	8	4	8	10	7	7	7	19	19	12	13	11	6	12	6	164
B7	9	0	12	2	7	6	7	7	9	16	3	1	7	6	14	20	5	131
B8	5	4	10	1	8	8	10	4	4	15	5	2	7	9	13	9	8	122
B9	5	4	2	1	5	8	3	2	1	11	8	2	3	7	9	17	7	95
B10	4	5	10	6	9	7	7	7	9	8	5	2	12	6	11	10	5	123
B11	6	5	12	10	10	10	6	6	3	17	17	5	13	10	16	16	10	172
B12	7	2	11	5	7	10	7	7	7	19	16	11	17	10	9	17	7	169
B13	6	2	11	8	6	7	7	6	6	13	9	3	8	10	0	8	6	116
B14	6	4	11	4	9	8	7	5	5	12	14	5	12	5	15	18	7	147
B15	4	2	7	3	3	9	2	0	3	8	4	2	6	11	9	13	6	92
B16	4	9	3	7	5	8	3	1	5	9	14	4	7	3	15	14	9	120
B17	8	3	5	5	7	7	3	2	7	2	5	4	5	10	8	17	7	105
B18	8	4	12	2	10	9	6	3	7	14	11	6	13	7	11	13	8	144
B19	10	6	13	1	8	8	8	5	5	12	20	6	8	7	11	11	9	148
B20	7	4	6	4	4	8	8	7	1	13	21	3	7	14	2	6	5	120
B21	4	2	7	4	10	9	8	2	4	14	13	4	9	4	9	15	9	127
Total points	131	86	174	87	146	168	120	88	108	263	241	97	200	181	216	295	149	2750
Aver. points	6.2	4.1	8.3	4.1	7.0	8.0	5.7	4.2	5.1	12.3	11.5	4.6	9.58	.61	0.3	14.0	7.1	131.0
Possible pts.	10	10	13	10	10	10	10	10	10	20	30	13	20	20	20	25	10	251
%	62	41	64	41	70	80	57	42	51	63	38	35	48	43	52	56	71	53.8*

*Average of the total per cent scores.

the steps in the life history, or gave the names of structures without the aid of drawings; and in other tests, he re-constructed and labeled drawings of plants, organs or parts of same.

The results of the tests for the four sections are shown in Tables 2-5. The average score for Section B, which finished the drawings in ink, excels that of Section A, which finished the drawings in pencil. These sections made about the same average intelligence score, and they were both early morning sections.

Table 4.—Scores made on tests by 19 high school students who finished their drawings in biology with ink.

Student	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15	Ex. 16	Ex. 17	Total
C1	7	2	8	3	4	7	6	2	8	19	14	3	11	20	4	14	9	141
C2	9	5	8	2	5	8	3	2	3	11	12	6	8	6	10	17	7	122
C3	10	5	12	9	8	10	7	7	5	18	10	4	12	16	11	20	7	171
C4	6	6	10	8	7	6	6	4	7	12	9	2	12	5	16	13	8	137
C5	6	4	12	7	4	9	7	7	9	11	11	4	7	7	2	10	9	126
C6	6	2	9	1	6	8	2	2	5	7	8	6	10	10	9	18	7	116
C7	1	0	6	1	4	8	5	0	5	7	9	3	6	7	5	13	4	84
C8	4	4	8	5	5	7	2	5	4	11	9	3	10	8	11	10	7	113
C9	8	0	9	4	4	5	9	2	5	12	5	4	9	11	0	3	6	96
C10	8	4	8	3	1	4	6	4	6	12	10	3	6	15	11	13	4	118
C11	7	2	8	4	5	9	3	2	4	10	8	3	12	8	10	14	6	113
C12	5	0	7	4	4	7	3	0	5	13	7	3	11	2	7	17	7	102
C13	8	1	10	3	6	4	4	5	6	17	10	5	10	8	12	22	7	138
C15	6	4	2	8	6	9	8	3	3	10	4	1	10	16	7	8	9	114
C16	10	2	9	5	1	4	5	5	6	15	6	4	12	9	5	13	4	115
C17	7	2	7	3	4	10	4	3	4	13	8	2	11	5	12	19	7	121
C18	8	0	6	4	2	7	6	4	4	6	14	2	8	8	0	4	5	88
C19	3	8	9	8	7	9	9	4	6	19	14	5	13	20	12	14	10	170
C20	9	2	10	8	9	5	9	8	8	12	11	6	8	10	7	11	10	143
Total points	128	53	158	90	93	136	104	69	103	235	179	69	186	181	151	253	130	2328
Aver. points	6.7	2.8	8.3	4.7	4.9	7.2	5.5	3.6	5.4	12 5	9.4	3.6	9.8	101	7.9	13.2	6.8	122.5
Possible pts.	10	10	13	10	10	10	10	10	10	20	30	13	20	20	20	25	10	251
%	67	28	64	47	49	72	55	36	54	63	31	28	49	51	40	53	68	50.3*

*Average of the total per cent scores.

The range of the total points for Section A is 153 and for Section B 99. The average score for Section C [ink] excels that of Section D [pencil]. These were afternoon sections and Section C made a slightly better average score on the intelligence test. The range of the total points for Section C is 87 and for Section D it is 120 points. The average per cent score for Sections A and D [pencil] would be [(50.2+43.4)÷2] 46.8, and for Sections B and C [ink] it would be [(53.8+50.3)÷2] 52.1.

The range of the scores made on the intelligence test is given in Table 6. This table also gives the section and class number, and the total points made by each student in all four sections. This table shows that there are 20 students of Sections B and C [ink] above the median (43.4) and 20 below the median; and,

that there are 17 students of Sections A and D [pencil] above the median and 17 below the median. The total points made by those students who are above the median and who did their drawings in ink is 2645 or an average of 132.3 points per student. The total points made by those students above the median and who did their drawings in pencil is 2152 or an average of 126.6 points per student. Below the median, we find that the students who finished their drawings in ink made a total of 2433 points or an average of 121.7 points per student, and that students who finished their drawings in pencil made a total of 1738 points or an average of 102.2 points per student.

Table 6.—Scores made on tests by 16 high school students who finished their drawings in biology with pencil.

Student	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15	Ex. 16	Ex. 17	Total
D2	9	9	13	8	10	8	9	5	6	19	17	5	9	13	13	15	10	178
D3	5	5	7	0	6	6	5	7	8	9	3	2	7	7	7	8	8	100
D4	9	2	7	1	7	9	7	1	3	19	8	1	7	9	10	17	8	125
D5	6	6	10	1	5	8	2	5	6	2	5	2	6	6	11	12	6	99
D6	4	2	4	1	5	4	6	1	0	8	2	0	5	5	0	7	8	62
D7	7	6	12	4	4	9	5	0	6	7	9	3	8	12	10	15	7	124
D8	6	1	7	4	3	9	4	4	6	6	3	0	6	4	3	17	10	94
D9	6	4	8	4	2	10	6	1	5	9	13	5	11	12	10	18	10	133
D10	6	2	9	4	0	8	3	3	3	4	5	1	7	3	9	6	10	83
D11	5	2	9	1	5	4	4	1	5	7	5	2	6	6	12	14	3	91
D12	7	4	9	3	3	5	5	4	4	2	3	1	5	6	2	0	5	68
D13	4	4	4	4	3	6	3	0	5	16	8	0	7	2	4	10	3	83
D14	5	0	6	1	1	5	1	3	1	7	3	0	4	4	2	5	10	58
D16	3	4	9	0	3	5	4	4	9	6	14	7	8	9	8	11	7	111
D17	7	4	9	4	4	8	5	2	7	7	7	2	9	8	4	13	6	106
D18	9	6	12	7	5	10	6	3	8	8	12	2	8	8	7	10	5	126
Total points	98	61	135	47	66	114	75	44	82	136	117	33	113	114	112	178	116	1641
Aver. points	6.1	3.8	8.4	2.9	4.1	7.1	4.7	2.8	5.1	8.5	7.3	2.1	7.1	7.1	7.0	11.1	7.3	102.6
Possible pts.	10	10	13	10	10	10	10	10	10	20	30	13	20	20	20	25	10	251
%	61	38	65	29	41	71	47	28	51	43	24	16	36	36	35	44	73	43.4*

*Average of the total per cent scores.

The range of scores made by each student on all tests [Table 7] shows that of the 40 students who inked in their drawings, 22 made a score above the median and 18 below. It further shows that of the 34 students who did their drawings in pencil 15 were above the median and 19 were below. A question would arise as to whether students above the median do better with ink and those below the median with pencil.

Those exercises that were to test the preparation of the students [Table 8] show that Section A [pencil] averaged 47.0%; Section B [ink] 56.2%; Section C [ink] 53.8%; and, Section D [pencil] 49.6%. Sections A and D [pencil] would have an average of 48.3% and Sections B and C [ink] would have an average of 55.0%.

In those exercises in which it was intended to test the results after the students had made the drawings as preparation and the exercise had been discussed in class [Table 9] Section A made an average of 55.8%; Section B, 59.3; Section C, 54.2%; and, Section D, 49.0%. Sections A and D [pencil] averaged 52.4%, and Sections B and C [ink] averaged 56.8%.

Table 6.—To show the range of scores made on the Intelligence Test, together with the students' numbers and the total points made by each student on all tests. [Median Intelligence Score = 43.5].

Intelligence Score	Student No.	Score on Tests	Intelligence Score	Student No.	Score on Tests
71.5	A4	232	43.0	A20	113
66.5	B3	136	43.0	C4	137
65.0	C3	171	43.0	C20	143
64.5	B2	185	43.5	A3	94
63.5	D4	125	42.0	A12	96
61.5	B8	122	41.5	A1	129
61.0	D11	91	41.5	C8	113
60.0	B15	92	40.5	D8	93
59.0	A10	141	40.0	B7	131
58.5	B19	148	40.0	C9	96
58.5	B14	147	39.0	B18	144
58.0	A11	128	39.0	C12	102
58.0	A15	128	38.0	C7	84
57.5	C5	126	38.0	C17	121
57.0	B12	169	37.5	A13	79
57.0	D7	124	37.5	C2	122
55.5	B20	120	37.5	C10	118
55.5	C19	170	37.5	D6	62
54.0	B16	120	37.0	B6	164
53.5	C15	114	37.0	B21	127
53.0	B4	127	36.5	B10	123
53.0	C16	115	35.5	B17	105
52.5	D13	83	35.5	C1	141
52.0	B1	121	35.0	D5	99
52.0	C11	113	34.5	B11	172
52.0	D17	106	33.5	A14	134
51.5	D2	178	33.0	A2	98
50.0	A17	145	33.0	A8	145
48.5	A6	103	32.5	D12	68
46.0	D18	126	32.0	B5	86
45.5	A5	103	30.0	B13	116
45.5	D10	83	30.0	C18	88
45.0	C6	116	30.0	D3	100
45.0	C13	138	30.0	D14	58
44.5	B9	95	27.0	A19	145
44.5	D9	134	26.0	A18	114
Med. 44.0	A7	122	24.5	D16	111

Total	4797	Total	4171
Total B & C [ink]	2645	Total B & C [ink]	2433
Total A & D [pencil]	2152	Total A & D [pencil]	1738
Aver. B & C	132.3	Aver. B & C	120.7
Aver. A & D	126.6	Aver. A & D	102.2

The third group of tests was aimed at retention. These tests were given one week in some exercises and two weeks in others after the exercise had been prepared by the student. The results [Table 10] show an average of 47.3% for Section A; 46.2% for Section B; 43.5% for Section C; and, 33.0% for Section D. The average for Sections A and D [pencil] is 40.2% and for Sections B and C [ink] it is 44.9%.

Table 7.—Range of total points made by each student on the tests. [Median = 121.5 points. N = 74].

Score on Tests	Student No.	Score on Tests	Student No.
232	A4	121	C17
185	B2	120	B16
178	D2	120	B20
172	B11	118	C10
171	C3	116	B13
170	C19	116	C6
169	B12	115	C16
164	B6	114	A18
148	B19	114	C15
147	B14	113	A20
145	A8	113	C8
145	A17	113	C11
145	A19	111	D16
144	B18	106	D17
143	C20	105	B17
141	A10	103	A5
141	C1	103	A6
138	C13	102	C12
137	C4	100	D3
136	B3	99	D5
134	A14	98	A2
134	D9	96	A12
131	B7	96	C9
129	A1	95	B9
128	A11	94	A3
128	A15	93	D8
127	B4	92	B15
127	B21	91	D11
126	C5	88	C18
126	D18	86	B5
125	D4	84	C7
124	D7	83	D13
123	B10	83	D10
122	B8	79	A13
122	C2	68	D12
122	A7	62	D6
Med. 121	B1	58	D14
Total B & C [Ink]	22	Total B & C [Ink]	18
Total A & D [Pencil]	15	Total A & D [Pencil]	19

In those exercises in which the student was asked in the test to identify plants or other structures or parts of the same Section

A averaged [Table 11] 46.1%; Section B, 53.9%; Section C, 51.3%; and, Section D, 42.1%. Sections A and D [pencil] average 44.1% and Sections B and C 52.6%.

Table 8.—Average score in per cent for those exercises in which it was planned to test preparation.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
1	43	62	67	61
2	28	41	28	38
4	35	41	47	29
6	74	80	72	71
7	55	57	55	47
Total	235	281	269	248
Aver.	47.0	56.2	53.8	49.6
Aver. Sects. A & D				48.3
Aver. Sects. B & C				55.0

Table 9.—Average score in per cent for those exercises in which the tests followed preparation and discussion.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
3	56	64	64	65
5	52	70	49	41
14	49	43	51	36
15	48	52	40	35
16	59	56	53	44
17	71	71	68	73
Total	335	356	325	294
Aver.	55.8	59.3	54.2	49.0
Aver. Sects. A & D				52.4
Aver. Sects. B & C				56.8

Table. 10.—Average score in per cent for those exercises in which the tests were given one and two weeks after the drawings had been made.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
8	39	42	36	28
9	66	51	54	51
10	61	63	63	43
11	36	38	31	24
12	31	35	28	16
13	51	48	49	36
Total	284	277	261	198
Aver.	47.3	46.2	43.5	33.0
Aver. Sects. A & D				40.2
Aver. Sects. B & C				44.9

In a fifth group of tests the students were asked to name plants, stages in their life history, or structures, etc., without the aid of drawings. In these tests [Table 12] Sections A and B made the same score, 55.7%; Section C made 50.1%; and, Section D made 47.0%. Sections A and D [pencil] thus average 51.4% and Sections B and C [ink] 52.9%.

Table 11.—Average score in per cent for those exercises in which the student was asked to identify plants or parts of the same.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
1	43	62	67	61
3	56	64	64	65
4	35	41	47	29
5	52	70	49	41
7	55	57	55	47
12	31	35	28	16
13	51	48	49	36
Total	323	377	359	295
Aver.	46.1	53.9	51.3	42.1
Aver. Sects. A & D				44.1
Aver. Sects. B & C				52.6

Table 12.—Average score in per cent for those exercises in which the student was asked to name structures, life histories, etc., without the aid of drawings.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
6	74	80	72	71
8	39	42	36	28
9	66	51	54	51
11	36	38	31	24
15	48	52	40	35
17	71	71	68	73
Total	334	334	301	282
Aver.	55.7	55.7	50.1	47.0
Aver. Sects. A & D				51.4
Aver. Sects. B & C				52.9

In the last group of tests the students were asked to reconstruct and label drawings of plants, organs, or parts of the same from memory. The scores [Table 13] show that Section A made an average of 56.3%; Section B made 54.0%; Section C made 55.7%; and, Section D made 41.0%. The average for Sections A and D [pencil] is 48.7% and for Sections B and C [ink] it is 54.9%.

In the test for Exercise 2 the students were asked to give definitions for terms which had been illustrated by the drawings.

On this test Sections A and C made 28%; Section B made 41%; and, Section D made 38%. Sections A and D [pencil] average 33% and Sections B and C [ink] average 34.5%.

Table 13.—Average score in per cent for those exercises in which the students reconstructed and labeled structures from memory.

Exercise	Sect. A [pencil]	Sect. B [ink]	Sect. C [ink]	Sect. D [pencil]
10	61	63	63	43
14	49	43	51	36
16	59	56	53	44
Total	169	162	167	123
Aver.	56.3	54.0	55.7	41.0
Aver. Sects. A & D				48.7
Aver. Sects. B & C				54.9

SUMMARY. The results of this study seem to indicate that students should finish their drawings in ink. It must be remembered that this study is not exhaustive or final, but that it does represent in a fairly objective manner the work of 74 students in high school biology for a period of five months.

There is one, and probably that is the only one, argument against finishing the drawing in ink, and that is it takes more time. Whether or not this time is wasted is a question—writers seem to say "yes," this study seems to say "no."

There are, on the other hand, several arguments in favor of the use of ink instead of the pencil to finish the drawing. In making freehand, outline drawings the pencil will naturally find its place in helping get proportions. But no one would desire to leave a drawing as finished when only the proportions are drawn in light pencil lines. In this case either the pencil or the pen must be used to finish the drawing. Since drawing with a pencil takes less time, the student may tend to become careless and leave loose ends, or fail to make the dim lines heavier. Dim, loose, or hastily drawn lines may correspond to similar ideas. These things are usually avoided when ink is used and replaced with those kind of outline drawings that will aid the student in getting clear and distinct conceptions. Moreover, the inked drawing with its clear definite lines tends to foster that pride which is much desired of students in their work.

ESTABLISHING A CIVIC CONNECTION BETWEEN THE CHILD AND THE COMMUNITY.

By Jessie A. Menzies,
High School, Janesville, Wis.

Childhood is such a ridiculously short period that we must realize that the boys and girls we are teaching today will be the men and women who will control the community tomorrow.

Those who have taught for any length of time have undoubtedly had the experience of having some strange young man introduce himself and to your surprise learn that he is the same Bill who only a short time ago wore knee trousers and shot paper "wads." Your surprise may be still greater when he tells you calmly that he is now *"A Moravian minister, a lawyer, or a traveling salesman for the Rexall Company."*

Since our pupils are so shortly to be in charge of matters of importance we must point the way so that when their time comes they will do their work well. Quoting from Dr. Elliot R. Downing of the University of Chicago:—

"We should try to impart to the child as much of the scientific knowledge now available as will enable him to live more healthfully, be a better citizen, use his spare time more wisely. In a word we should give him that knowledge which is *socially worth while* to *him as a child."*

Doubtless you can each think of many instances in your communities of tragedies due to *Wrong* and *Unhealthful* living, of unwise civic measures passed because Civic leaders had not been taught to reason things through but jumped at conclusions and of leisure hours wasted or spent in a manner such that the individual was not "Making the Most of Life."

Perhaps it might be interesting to briefly consider some of the general characteristics which the most successful all-around citizen should possess, and to see if science offers ways and means of developing these traits of character.

In the first place such Sciences as Civic Health, Civic Biology, Nature Study, and General Science in their modern aspects have as one aim the training of the observation and the awakening of interest in the world about us. Certainly the successful citizen should be *wide awake* readily realizing the needs of his community and imbued with a sense of responsibility for helping fulfill these needs.

Not only should this sense of responsibility and desire for usefulness be felt, but, if the citizen is to occupy a position of

honor and trust, he should have a sixth or civic sense. By this I mean a broad, unselfish view of the needs of the community rather than a narrow, selfish, view which would cause him to see one side only and that side his own. The Biological Sciences furnish many illustrations of unselfish activity. Such passages as the following from a well known Biology text are probably very familiar:—

"Biology ought to make us better men and women by teaching us that unselfishness exists in the natural world as well as among the highest members of society. Animals lowly and complex, sacrifice their comfort and their very lives for their young. In the insect communities the welfare of the individual is given up for the best interests of the community. The law of mutual give and take, of sacrifice for the common good is seen everywhere. This should teach us, as we come to take our places in society, to be willing to give up our individual pleasures or selfish gain for the good of the community in which we live."

Thus society will be benefited.

Selfishness and lack of Co-operation are not the only causes for the passing of unwise civic measures, however; rather this is often due to the lack of ability on the part of the small town or rural man and woman to *reason through a given problem to its logical conclusion.* In a recent issue of the Nature Study Magazine this statement is made "Democracy is only safe when its citizens are capable of *reasoning out its many problems.*" Among other subjects, science offers splendid opportunity for tracing from observation through experiments and hypothesis to the final conclusion. Even in the lower grades or in the Junior High School this ability to reason may be encouraged, for the child's mind naturally will follow some such train of thought as this upon seeing some new piece of apparatus or some unusual object:—"What is that? How does it work? Let me try to work it, could I make some other thing work in the same way?'

This furnishes an excellent opportunity to guide this natural process into that orderly reasoning which John Dewey calls reflective thinking.

The good citizen in the community should also have certain cardinal virtues and certain desirable habits which I think may be acquired and developed through the science courses of our schools. For instance, one way in which that most desirable trait—truthfulness—may be developed is by pointing out and insisting upon it, that real rather than the false results of an

experiment be recorded—however desirable the latter might be. Similarly the habit of promptness will be acquired if the teacher is herself prompt in getting laboratory work started and if she creates an atmosphere conducive of promptness and efficiency. Children are great imitators.

Last but not least, science work lends itself to the development in the boy or girl of self-confidence without self-conceit for few subjects prove, as clearly to the pupil as do experimental sciences, that careful, painstaking procedure will usually accomplish satisfactory results and vice-versa. In other words—that one's best is usually good enough and that anything less, *usually is not.*

Sciences furnish an antidote for undue self-satisfaction. Always there are new and yet unexplored fields just ahead. Did you ever meet a radio fan who thought he knew *all there* was to know about radio?

I believe that there is a way of creating Civic Interest, developing Civic Initiative and encouraging Civic Responsibility in every science course of the high school curriculum. The problems may be selected with the idea of this development being an ultimate aim. Perhaps I can best illustrate what I mean by explaining how our science course is planned at Janesville, Wisconsin and by suggesting for the various sciences, problems which lend themselves to the establishing of this Civic Connection.

In the Seventh Grade, or first year of the Junior High School we give a course which we call *Civic Health.* Our aim in this course is to help the pupils acquire correct *health habits.* We feel that merely telling the child that certain modes of hygienic living are desirable is not enough, but that we must help him learn to live and think in such a way that he will improve himself, his immediate home environment and his community.

If certain children come to school with dirty hands or ears, the privilege of supplying soap, a towel, and a brush is given to certain members of the class, and day after day the children are inspected by monitors and made to clean themselves up right in the room before participating in the class exercise.

It took me from September sixth until December twentieth, 1923, to get one child to come to school habitually clean. At the end of these three and one-half months, however, I had not only succeeded in this but had helped him break the habit of smoking cigarettes. I considered both these accomplishments decidedly worth while.

In like manner, instead of *merely telling* children that the teeth should be kept clean and that a tooth-brush is a good thing to have, the members of the class should bring their tooth-brushes to school—the teacher should demonstrate how a brush may be used—and the entire class should go through the motions not once but on successive days.

Perhaps the present overly high rate of mortality among infants might be reduced if in the schools the girls were shown the proper preparation of a baby's bottle and *had some practice in its preparation.* The following is a practical problem in Civic Health:

Problem—Is the milk supply of our community sanitary, and if not may it be made so?

Material—Samples of milk brought from homes and representative of the products of various dairies. Squares of straining cloth.

Method—Strain the milk. Examine residue on cloths.

Observation—Is foreign matter present? Do some samples seem to show more dirt than others?

Result—Is there more impurity which is visible to the naked eye in the city's milk supply than there should be?

Conclusion and Action—What steps might be taken to remedy this situation?

This project was carried through with success several years ago in a city located in the Southern part of Wisconsin. A committee from the class conferred with the local health officer. Failing to get results an appeal was made to the city attorney—from there the committee took the matter to the State Capital and secured results through inspectors. The source of supply and the dairies in and near the city were cleaned up.

A similar attempt was made in the same city to improve the sanitation of the depot. This, however, was not successful. The depot agent was appealed to, and letters were written to main offices of the road, but no results were secured.

Since we are living in a day when one is inclined to go to one extreme or the other in work—either using up his vitality and lowering his resistances at too early an age, or never waking up to what is required of him but remaining a slacker all his life, I would suggest this as a civic health problem of quite a different type—but as one which has possibilities e. g. *How may teh worker overwork and may be also underwork?*

There are at least two dangers in presenting Civic Problems

of this type. To prevent one—care should be taken not to antagonize the city authorities or owners of industries which are to be considered. For that reason a quiet conference would have an advantage over a petition which might be misunderstood.

The other danger is that we may develop a race of faultfinders —who always see something wrong in every situation but let it go at that—cannot suggest the cure.

In the eighth grade or second year of Junior High School, we present a course in Nature Study. Our idea in presenting this subject and the fact that it has a civic aspect can perhaps best be expressed by quoting from a recent article by Thornton W. Burgess:—

"Nature was the pioneer teacher. She still is the greatest of all teachers. Man was little above the beasts of the field until he became observant of his surroundings, and from these observations endeavored to better his own conditions. This was nature study pure and simple, and the beginning of education. Every great advance which the human race has made, from the discovery that fire could be made man's servant, to the development of radio, has been through increased understanding of Nature's laws. Art began in the first crude attempt of man to reproduce on the walls of his cave images of the things he saw. Music's birth was in his first awakening to a sense of melody in the songs of birds, ... Poetry came into existence when he first sought to express his awakening sense of the beauty surrounding him.

Mrs. John Dickinson Sherman, representing the sentiment of the General Federation of Woman's Clubs, says:—

"And while the child is making friends with Mother Earth, and she reveals her treasures to him, he will have developed physical health, strength of character, understanding, and human sympathy, vital attributes which every mother wants her child to possess.

Perhaps there are fewer opportunities for presenting specific problems which would form a civic link here than in the civic health courses. However, such problems as:—

I. Why are some Plants called weeds, with the attempted project of ridding a given area of them;

II. A problem dealing with recognizing the fly as a public nuisance and a campaign against it;

III. Work leading to the desire to beautify one's surroundings with shrubs and flowers;

IV. To attract and feed the birds in winter are all suggestive.

General Science follows Nature Study in the ninth grade or last year of our Junior High School Work. In this course we have tried the plan of having the pupils suggest lists of questions concerning chemical and physical phenomena which they would like to help in solving. We feel that greater interest is created and more satisfactory results are obtained when this method of determining the content of the course is employed than when the content of the text is followed page by page. We feel that in too many instances the somewhat confused and bored victim of the class room has had thrust upon him information which he has with a greater or less degree docily accepted and promptly forgotten.

Such problems as these were suggested from the lists handed in by the ninth year pupils:—

"What makes an aeroplane stay up in the air?

"What happens when the gears are shifted in a car?

"How does pulling a trigger make a gun go off?

"What carries your voice when you telephone?

"How is it you can see yourself in a mirror?"

After having used this type of problem for a year, we discovered a book entitled Common Science by Carleton W. Washburn, Superintendent of Schools at Winnetka, Illinois. We now use this book, as a text. The foundation of the book is a collection of 2,000 questions asked by school children. One feature which makes it especially valuable is the fact that at the end of each section of every chapter there is a paragraph entitled application. In this paragraph, thought questions are asked, the answering of which will give valuable information that may be applied in situations of everyday life.

To illustrate—this application follows a section on the law of Gravitation:—

"Some boys made themselves a little sailboat and went sailing in it. A storm came up. The boat rocked badly and was in danger of tipping over. 'Throw out all the heavy things quick!' shouted one. 'No, no, don't for the life of you do it!' called another. 'Chop down the mast—here, give me the hatchet!' another one said. 'Crouch way down—lie down in the bottom!' 'No, keep moving over to the side that is tipped up!' 'Hold the things in the bottom of the boat still so they'll not keep rolling from side to side!' 'Jump out and swim!' Every one was shouting at once. Which part of the advice would you have followed if you had been on board?"

A study of relative humidity leading to examination of the humidity of public buildings—as a factor in their ventilation or the question of sewerage disposal as it affects the purity of water near swimming beaches both would lead to General Science problems of a Civic nature.

In the tenth year a choice is given of Geography or Biology. The following project worked out by Miss Doris Clough—a Wisconsin teacher—is illustrative of a Geography project conducive of encouraging Civic Interest, Initiative and Responsibility.

NAME OF PROJECT.

AIM—To give the pupil a better appreciation of the geographical source of his everyday foods, to awaken his interest in regard to the regions from which his foods come and to enable him to understand better as he grows older the effect that unusual climatic conditions, politics, new demands, and so on, have upon the supply and consequent cost of foods to the consumer.

This project was worked out successfully with ninth grade pupils.

FIRST STEP—A 6′x8′ piece of wall board was purchased and on it was drawn a map of the world. All lines were in India ink, and only names of the continents, the important bodies of water, and the countries and cities referred to in the project were printed on the map. The map was colored and when finished was a matter of great pride to the students. The first step, I deemed only a means to the end, and so therefore it was entirely voluntary work and done outside of school work.

SECOND STEP—Next it was necessary to work out the list of foods, or the menu of the average American family for each of the three meals—breakfast, luncheon, and dinner.

THIRD STEP—Each child chose the particular article of food for which he wished to assume all further responsibility in the project, made a thorough study of the food, reported on it to the class, and on the day assigned brought this article of food to school.

FOURTH STEP—Red, white, and blue "baby ribbon" was purchased. All the foods which were on the breakfast list were placed at one end of a table. To each was attached a piece of red ribbon, the other end of which led to the point on the map where this food was produced. (Ribbon was fastened to map by means of a thumb tack. The map was hung back of the table so its lower edge just touched the table.) The white ribbon was used for the luncheon foods, and the blue for the dinner foods.

In selecting the point on the map from which a certain food came, we tried to choose the most important producing area, or the one which would be most likely to be supplying American tables.

CONCLUSION—We depend upon the whole world for our daily foods. Therefore it is of vital importance to us to know what is going on in the other countries of the world and to understand the conditions which affect the demand and supply of foods.

Since Biology is the study of life and of *how* to live, its problems will, by the very nature of the subject, tend to stimulate interest in and a sense of responsibility for bettering the Community.

There are many cases of unnecessary unhappiness, illness, and even death in nearly every locality. Children often are brought up in surroundings where the sleeping conditions, the kind of food cooked and served, the habits of parents and associates all tend to hinder them or cause them to fail in the struggle for existence. This of course is to be lamented. The older generation is perhaps so fixed in its way of doing things that we can do little even indirectly, to make this situation better.

However if we can teach Biology in such a way that the children will first understand life in general and later their own bodies and the care of these so that when they become our future homemakers they will create right and healthful environments for themselves and the future generation—and will have a desire to do their share toward keeping the city up to the very highest standards of which they know—I think we will have accomplished the purpose for which the subject has been introduced into so many schools throughout America.

I have at hand a pamphlet which is the result of a project to reduce the number of cases of Influenza in a nearby town. Year after year the disease had raged in this town with no attempt on the part of the citizens to check it. The school took up the work of discovering the history, cause, prevention and care of the epidemic;—interested people in town in all walks of life in their work, by asking questions and soliciting opinions of doctors and others who had had experience with the disease. This work was done in connection with Civics but could very well follow the study of Bacteria and their Relation to Disease in Biology.

Following the Biology and Geography we have Chemistry in the eleventh, and Physics in the twelfth year of the Senior High School.

Perhaps it is not so easy to make obvious connections between Chemical lore and everyday life situations as it is to make such connections in presenting the other sciences, however, I believe that authorities on the teaching of Chemistry agree that the subject should be presented in such a way that the pupil will desire to know and prove truth for its *social utility.*

George Ransom Twiss in his *Principles of Science Teaching* makes this statement:—

"Have the pupils do things with the common Chemical substances whose reactions are not too complex, and see to it that they observe accurately what happens and *correctly interpret* their observations. Give them only so much of theory as will help them better to interpret and organize the facts that they become acquainted with in the laboratory, at the demonstration table, and in the World outside in the home, on the streets, in the factories or on the farm."

And he goes on to say—"It is a tendency to make Chemistry teaching a cramming process, instead of an opportunity for Self-Development—for learning how to *do* and *how to get to the bottom of a question*—that defeats the very purpose for which we profess to teach Chemistry."

In the School Review for Dec., 1923, I noticed an article in which it was suggested that radical reforms are necessary in the teaching of Chemistry in the Nation's High Schools. Dr. John E. Teeple of New York City, treasurer of the American Chemical Society, says that High School courses should aim to give the student a *broader understanding of the field of Chemistry and of its utility to man rather than to impart what he calls the meager and uncertain knowledge necessary to college requirements.*

Though recent text books of Chemistry such as Elementary Principles by five prominent high school instructors of New York City (Allyn Bacon & Co.) show no startling new or radical changes in subject matter or treatment, less theoretical matter and fewer detailed descriptions which would act as barriers to the acquiring of essential facts, are included. The pupils are led to arrive at generalizations. They are made to realize the great truths brought home to us by the World War that our country has the ability *to supply her own human needs*, and that Chemistry has not yet exhausted its ability to make mankind live better.

Twiss in discussing the teaching of Physics points out a danger of going to extremes in using exclusively experiments that have to do with home and industrial application. He says that in this

method the *underlying principles may not be brought out with sufficient clearness, force and reiteration, and that the pupils' knowledge may be left in a scrappy and unorganized condition*—but on the other hand he adds:—

"We should always remember that real knowledge of abstract principles means the ability to apply them to concrete personal work and conduct, and that they are useless to the individual *unless he has the ability and the will so to apply them as to make himself in some way more useful to mankind.*"

We have much recent literature of a type which would indicate that an attempt is being made to link up the experiences of the pupil in the schools with the situation he is encountering or may later encounter out in his community.

"SCIENCE REMAKING THE WORLD"

—a remarkable collection of parts of lectures given at Teacher's college—Columbia University during the summer of 1922 is offered to the public at 12 cents a copy. The editor asks the question—"Why publish such a volume?"—and answers it by saying—

"Because the citizen of our day uses modern sciences at each turn of the day's work!"

In the new book by Robinson, author of *Mind in the Making,* and entitled *Humanizing Knowledge,* we are reminded that a few years ago Science books were written by Scienitfic men in such a technical style that they could be read and appreciated only by scientists. Now the style is so clear and the illustrations so vivid that all may read, enjoy and apply the information which they contain.

The Handbook of Nature—published by the Comstock Publishing company, *The Nature Magazine,* the *National Geographic* and *Hygeia*—a magazine devoted to health training, all offer reading material which may help the teacher to train wide-awake, observing and efficient citizens.

I think it should be our aim and desire in Science to turn out men and women who will not only be in possession of a certain amount of abstract knowledge which they may all too soon forget, but who will have developed such traits and acquired such a view-point that they will be a credit to themselves, their families and their communities.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

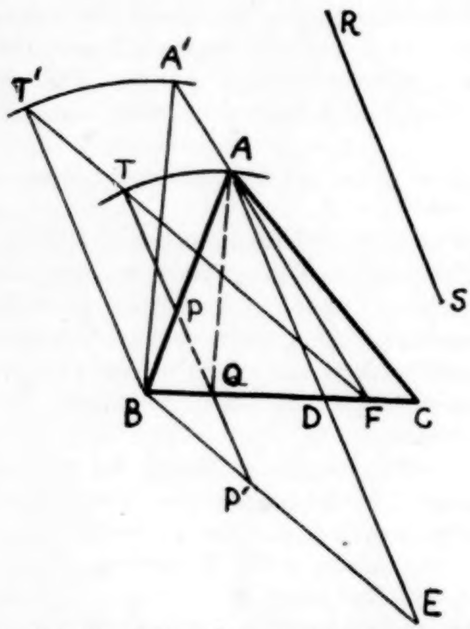
SOLUTIONS OF PROBLEMS.

846. *Proposed by George Sergent, Guatemala.*

Given $\triangle ABC$ and a line RS. A line is drawn parallel to RS intersecting AB at P and BC at Q; and Q is joined to A. Determine the position of P and Q so that $PQ+QA$ equals a given length, l.

Solved by the Proposer.

Analysis. Suppose the problem is solved with $PQ \| RS$, and $PQ+QA=RS$. Prolong PQ at both ends, taking $QT=QA$, $QP'=QP$. Then $TP'=RS$. Draw BP′ and prolong it till it meets in E the parallel through A to RS. Since $PQ=QP'$ it follows that $AD=DE$.



Draw BT′ equal and parallel to RS, and T′F parallel to BE, intersecting BC in F. Since BT′ and P′T are equal and parallel, T′ and T are on the same parallel, T′F, to BE. The triangles QTF and BT′F are similar and similarly situated, F′ being their center of similitude; the ratio of similitude is $FQ/FB=QT/BT'=QA/RS$.

Draw $BA' \| QA$, and take $BA'=RS$. Draw FA and FA′.

In $\triangle$s QAF and BA′F, $FQ/FB=QA/BA'$ $(=QA/RS)$. Hence these two triangles are similar; F is their center of similitude, and FAA′ is a straight line.

From the analysis we deduce the following construction:

Construction. Draw $AD \| RS$, and prolong it to E, so that $AD=DE$. Draw BE. Draw $BT \| RS$, and lay off $BT'=RS$. Draw $T'F \| BE$, intersecting BC in F. Draw FA and prolong it till it intersects, in A′, the circle described with B as center and with BT′, or RS, as radius.

Draw A′B, and through A a parallel to A′B, intersecting BC in Q, one of the required points. Through Q draw a parallel to BT′, intersecting AB in P, the second required point.

Proof. To prove that PQ+QA=RS, prolong QP till it crosses in T the circle described with Q as center and with QA as radius. Then QA=QR and PQ=P′Q. Hence PQ+QA=P′Q+QT=BT′=RS.

Also solved by *J. Murray Barbour, Ardmore, Pa.; Nathan Barotz, New York City; Thomas E. N. Eaton, Redlands, Cal.; J. F. Howard, San Antonio, Texas;* and *Michael Goldberg, Philadelphia, Pa.* All of these solutions involved deriving a formula for the length of BQ or BP and then basing the construction on the algebraic nature of the formula.

847. *Proposed by C. E. Githens, Wheeling, W. Va.*

Prove that the product

$$2^{\frac{1}{4}} \cdot 4^{\frac{1}{8}} \cdot 8^{\frac{1}{16}} \cdot 16^{\frac{1}{32}} \cdot \ldots\ldots \text{to infinity}$$

equals 2.

Solved by H. A. Obenauf, Culver Military Academy, Culver, Ind.

The series may be written in the form

$$2^{\frac{1}{4}} \cdot 2^{\frac{2}{8}} \cdot 2^{\frac{3}{16}} \cdot 2^{\frac{4}{32}} \cdot \ldots\ldots$$

and this is equal to the number 2 with the exponent

$$\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+\frac{4}{32}+\frac{5}{64}+\ldots\ldots$$

Let $$S=\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+\ldots\ldots=\frac{1}{2^2}+\frac{2}{2^3}+\frac{3}{3^4}+\ldots\ldots$$

Then $$2S=\frac{1}{2}+\frac{2}{2^2}+\frac{3}{2^4}+\ldots\ldots$$

Subtracting S from 2S, gives

$$S=\frac{1}{2}+\frac{1}{2^2}+\frac{1}{2^3}+\ldots\ldots$$

which is an infinite geometrical progression with $a={}^1/_2$, $r={}^1/_2$.

Hence S=1, and the given product equals 2.

Also solved by *John Ankebrant, River Rouge, Mich.; J. Murray Barbour; Nathan Barotz; Michael Goldberg; C. F. Holmes, Elizabeth City, N. C.; J. F. Howard; R. T. McGregor, Elk Grove, Cal.; Philomathe, Montreal, Canada; Henry Ruzicki, Lacey, Wash.; Donald C. Steele, Greensburg, Pa.;* and the *Proposer.* In most of the solutions the sum of the exponents was found by using S and 2S, or S and ½S, or by writing S as the sum of a number of series each of which is an infinite geometrical progression; thus:

$$\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+\frac{4}{32}+\ldots\ldots=\left(\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\frac{1}{32}+\ldots\ldots\right)$$

$$+\left(\frac{1}{8}+\frac{1}{16}+\frac{1}{32}+\ldots\ldots\right)+\left(\frac{1}{16}+\frac{1}{32}+\ldots\ldots\right)+\ldots\ldots$$

$$=(1/2)+(1/4)+(1/8)+\ldots\ldots=1.$$

848. *Proposed by Norman Anning, Ann Arbor, Mich.*

Solve: $\tan x+\tan 4x=2\tan 3x$.

Solved by *Philomathe, Montreal, Canada.*

We have successively

$$\tan x+\tan 4x = 2\tan 3x$$

$$\frac{\sin x}{\cos x}+\frac{\sin 4x}{\cos 4x}=\frac{2\sin 3x}{\cos 3x}$$

$$\frac{\sin 4x\cos x+\cos 4x\sin x}{\cos x\cos 4x}=\frac{2\sin 3x}{\cos 3x}$$

$$\frac{\sin 5x}{\cos x\cos 4x}=\frac{2\sin 3x}{\cos 3x}$$

$$\sin 5x\cos 3x = 2\sin 3x\cos x\cos 4x$$

$$\sin 5x \cos 3x = \sin 3x (\cos 5x + \cos 3x)$$
$$\sin 5x \cos 3x - \cos 5x \sin 3x = \sin 3x \cos 3x$$
$$\sin 2x = \tfrac{1}{2}\sin 6x$$
$$2\sin 2x = 3\sin 2x - 4 \sin^3 2x$$
Hence, $\sin 2x = 0$, and $\pm \tfrac{1}{2}$.
Therefore, $x = n\pi/2$ and ${}^1/_2 n\pi \pm {}^1/_{12}\pi$.

Also solved by *J. Murray Barbour; Nathan Barotz; Thomas E. N. Eaton; Michael Goldberg; C. F. Holmes, J. F. Howard; George Sergent;* and the *Proposer.* In various ways the given equation was reduced to one of the forms:

$$(1+\tan^2 x)(\tan^4 x - 14\tan^2 x + 1) = 0,$$
or
$$16\sin^4 x - 16\sin^2 x + 1 = 0.$$

J. F. Howard raises the question whether $\tfrac{1}{2}n\pi$ can really be called a solution when n is an odd integer. *Nathan Barotz* states the solution as $n\pi$; $n\pi + 75$.

849. *Proposed by Burrell Morgan, Krollitz, W. Va.*

If a man charges $2 for sawing a cord of wood consisting of 3 foot lengths into 3 pieces, what should he charge for sawing a cord consisting of 6 foot lengths into 4 pieces. Derive also a formula for the general problem, and base the solution on proportions, if possible.

Solved by Nathan Barotz, New York City.

Assume that the wood to be cut consists of k feet. If each length is l feet there will be k/l lengths. When cut into c pieces, $(c-1)$ cuts are necessary making the total number of cuts $k(c-1)/l$.

When the pieces are L feet long, there are k/L lengths. And if cut into C pieces the total number of cuts is $k(\mathrm{C}-1)/\mathrm{L}$.

If the expense in the first case is e and in the second case is E, then

$$\frac{e}{\mathrm{E}} = \frac{k(c-1)/l}{k(\mathrm{C}-1)/\mathrm{L}} = \frac{\mathrm{L}(c-1)}{l(\mathrm{C}-1)}$$

In the given case, $e = 2$, $l = 3$, $c = 3$, $\mathrm{L} = 6$, $\mathrm{C} = 4$. Hence $\mathrm{E} = 1.50$

Also solved by *J. Murray Barbour; Francese Buckmaster, Redlands, Cal.; Thomas E. N. Eaton; J. F. Howard;* and *Helen Scullion, Notre Dame Ladies College, Montreal, Can.*

850. *For High School Pupils. Proposed by Paul Ligda, Oakland, Cal.*

Two competing merchants are selling suits of the same kind and at the same price. Each sells 12 suits. Then A cuts the price $3 on each suit and sells 8 suits at the new price. B cuts his price $6 on each suit and sells 18 at the new price. If the total sales in dollars are the same for both, what is the amount of the sales?

Solved by June Constantine, West H. S., Minneapolis, Minn.

Let x = the original price in dollars per suit.
Then $x-3$ = A's price after the reduction.
$x-6$ = B's price after the reduction.
$8(x-3)$ = amount taken in by A after the reduction.
$18(x-6)$ = amount taken in by B after the reduction.

Since before the reduction each merchant sold the same number at the same price and since their total sales are equal,

$$8(x-3) = 18(x-6) \text{ or } 8x - 24 = 18x - 108.$$
$$\$8.40 = x = \text{original price.}$$

Amount first sold $= 12x$ or $100.80. Amount sold later $= 8(x-3)$ $=$ $43.20.∴ total sales were each $144.00.

Also solved by
Philo H. S., Ill., Ena Shepherd.
Santa Clara, Cal., Emmet Henderson.
Kensington H. S., Philadelphia, Pa., Tillie Dantowitz.
Denfield H. S., Duluth, Minn., Lawrence LaFave.
Carthage, Mo., June Morgan; Edmond Rawles.
Siskiyou H. S., Yreka, Cal., Fred Lange; Elsie Tebbe.
South H. S., Worcester, Mass., Eugene Lavallee; Thereon K. Lord; Frances E. Royal.
Cordova, Alaska, Phyllis Downing; Donald Foster; Sadie Pratt; Mike Shepard, Julian Storey.
Northeast H. S. Kansas City, Mo., Catherine Drake, Mildred Day,

Mildred Freeman (who presented the best *check* of the solution); *James Northcutt, Romeyn Peck, Anthony B. Pellegrino, Dave Simon.*

Redlands, Cal., Henton Brenan, Francese Buckmaster, Theodore Byyny, Willis Cadwallader, Barry Dibble, Jack Faris, Carmen Frye, Elizabeth Henderson, Frances Henney, Russell Huckaby, Frances Mikel, Grace Oosterdeert, Marjorie Pohl, Seymour Tucker, Edith Turner, Jeannette Vinton

PROBLEMS FOR SOLUTION.

861. *Proposed by the Editor.*

Find a formula for telling in what particular month and year any given problem, as number 546 for example, was solved in this department (five problems are solved each month excluding July, August, and September).

862. *Proposed by Philomathe, Montreal, Canada.*

At the end of problem 831 occurs this bold assertion: All geometrical constructions which use only the compass and straight edge can be performed by the compass alone. Hence the following is proposed:

By the compass alone find the mid-point of a line segment.

863. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given $2s$, c, and h_c, construct the triangle.

864 *Proposed by Michael Goldberg, Philadelphia, Pa.*

Prove that $\csc 10° + \csc 50° - \csc 70° = 6$.

865. *For High School Pupils. Proposed by I. N. Warner, State Normal School, Platteville, Wisconsin.*

A, working upon a certain task, can do it alone in 15 days; B requires 18 days alone, C, 21 days, and D, 24 days. Later on these same four men work together upon a job agreeing to accept payment according to their working rates. The total pay is $79.95. How shall the money be divided among the four men?

THE GEOMETRY OF ETHICS.

EDWIN E. SLOSSON

You may, if your arithmetic is erratic, add up a column of figures a dozen times and get different sums. Only one is correct. It is necessarily the same about the more complicated problems of life, only we cannot see it so clearly. Elementary mathematics is the only science man has mastered so he can put real confidence in the results of his ratiocination.

Science, which aims at certainty, approaches it by the method of trial and error, thousand of trials, thousands of errors, before and approximation to the truth is attained. Truth is one; falsehoods are infinite.

Nine-tenths of the ideas that come into our heads are wrong. The object of education is to select the one that is right.

Nine-tenths of the impulses that beset us are wrong. The task of civilization is to suppress the nine.

No matter how complex the problem, there is never more than one right answer, one right way out, one straight and narrow path, hard to find, and hard to follow, one road leading out of the maze of many false turns; all the others are blind alleys or paths that return upon themselves.

It is an axiom of plane geometry that there can be only one straight line connecting two points. From the point where we are to the point where we wish to go, there is only one short straight road, all the other possible paths are more or less divergent and devious.

The rules of conduct are as invariable and absolute as the rules of geometry. The only difference is that we cannot see so clearly in ethics as in mathematics. The falling of a fog makes our road obscure but does not alter its length or direction.

There is only one best move in a game of chess, whether we know what it is or not. There is only one wisest action in any emergency, whether we know what it is or not.

There are no indifferent actions, no equivalent choices. It may seem a matter of indifference which street you turn down in your morning stroll, but that is because you do not know what fate awaits you around the corner. If you turn down First Street you may be run over by an automobile. If you turn down Second Street you may meet a man who will make your fortune. If you turn down Third Street you may catch a fatal microbe. If you turn down Fourth Street you may see the girl you want to marry.

If you knew, you could choose. But all the streets look equally inviting and not knowing which is the best you leave it to "chance." You toss up a penny, but it is not a matter of chance which face of the penny falls uppermost for that is determined by the inevitable interaction of the forces of gravitation and rotary momentum.

Even if you could know what lay before you on each of the optional avenues, you would not necessarily be able to select the best. It may be that Second or Fourth Streets would lead you to more unhappiness than First or Third. Not knowing which is the most fortunate road you would be grateful if on that morning you should find all the others blocked by signs of "Street closed. Detour." You would be glad to be forced into good fortune if you could not find your own way. Nobody wants freedom of choice except in those cases where choice would lead him toward his goal, whatever that may be.

Nobody has a right to do wrong. Nobody but a congential idiot would claim such a right and nobody but an incorrigible criminal would want to exercise it.

Every sane man wants to do what is for his best interests and every good man wants to do what is for the best interests of others as well.

There can be no two opinions about this. The only thing we disagree about is as to what is for the best interests of ourselves and society. This is due solely to our ignorance for if we all knew always what was best to do, we should of course all want to do it. But because we don't and can't always know, we have to allow considerable latitude as to thought and action, the more latitude in those fields where there is the more uncertainty. There is obviously but one course that ought to be pursued or would be pursued if we could know in advance the outcome of all our options.—|*Science Service.*

STUDY GAME BIRDS OF ALASKAN TUNDRAS.

The work of a scientific expedition that crossed Alaska to study birds on the shores of the Arctic Ocean was recently related by Herbert W. Brandt of Cleveland to the American Ornithologists' Union of Pittsburgh.

The party went from Seward, their port of entry into Alaska, to Fairbanks by rail, and then struck out overland by dog sledge to Hooper Bay. They traveled 850 miles in forty days, twenty of which were very stormy, and encountered temperatures as severe as 30 degrees below zero. Hooper Bay, their base for the study of water birds, can be reached by boat only during July and August.

The principal object of the expedition was the study of migratory water birds on their summer pastures. Many of these species are important game and economic species whose habits are of considerable practical interest. However, some observations were made on the few species of birds that live in the interior, during the long sledge journey. Perhaps the most interesting of these is the Alaskan blue-jay, which lays and hatches its eggs during March, when the mercury frequently drops to 40 or 50 degrees below zero.

The country along the seashore consists largely of low sand dunes and tundra where the birds are literally countless. Why they go so far north is no mystery, for during the crowded days of the short Arctic summer the tundra is spread with food like a table. Mr. Brandt stated that birds feeding on these northern plains pick up seed, berries and insects just as rapidly as hens in a prosperous farm yard pick up grains at feeding time; and that all the birds he killed for food or specimens were heavy and fat.

The tundra also supports a large population of small animals allied to the field mice, which supply provender for snowy owls and other flesh-eating birds.

The expedition enlisted the services of the primitive Eskimos of the region. Part of them located the nests of desired species, and showed themselves to be patient and skilled searchers, finding nests that eluded even the eyes of the scientists. Others were taught to blow eggs and to prepare bird skins. In this latter work the girls were especially successful, for they have had much practice in making birdskin garments for themselves.

Among the most abundant of the birds of the region is the eider duck. Flocks averaging over a thousand specimens flew over, twelve or fifteen of them in succession. Ducks of other species, four kinds of geese, and numerous wading birds, also abounded.

One of the most difficult of the birds, from a collector's standpoint, was the snowy owl. It lays from nine to a dozen eggs, but begins sitting from the first. Consequently when the collector undertakes to blow a nest of eggs, he finds them in all conditions, from quite fresh to nearly ready to hatch. Mr. Brandt added that he did not undertake the preparation of more owls' eggs than were really needed.—[*Science Service.*

CHICAGO GIVES FRESHMEN A WEEK FOR PREPARATION.

To enable its 800 freshmen to begin their work under favorable conditions, the University of Chicago will have its freshmen arrive September 25 instead of October 1. To welcome and acclimate the incoming students, a five-day program was arranged for registration, physical examinations, tests in English composition, receptions, and talks by the deans and others on topics vital to the future of the student.

All secondary school teachers in the State of New York are subject to the principle of "equal pay for equal work," by the terms of a law passed by the legislature for 1924. Ten other States prohibit discrimination between men and women teachers in the matter of salary.

GOOD RESULTS FOR VISIT OF PAN AMERICAN HIGHWAY COMMISSION.

A Pan American Confederation of Highway Education Boards with a constituent board in each country, the preparation of a program for the Pan American Highway Motor Conference to be held in Buenos Aires, May, 1925, better training for highway engineers, and the prospective opening of large rural districts in the Latin American countries, thus facilitating the establishment of rural schools and in every way encouraging more advanced civilization, are some of the results of the Pan American Highway Commission's intensive study of highway problems in the United States. This commission recently visited the United States at the invitation of the Highway Education Board of which the United States Commissioner of Education is chairman.

NEARLY THREE-QUARTERS OF A MILLION TEACHERS.

The total number of public-school teachers in the United States in 1923 is estimated by the Bureau of Education to have been 729,426. This estimate does not include superintendents, supervisors, and principals. Forty-three per cent of these teachers, or approximately 313,805, are classed as rural teachers. In this classification rural is interpreted to include open country, country villages, and towns not maintaining independent city systems.

KANSAS CLAIMS LEADERSHIP IN EDUCATIONAL BROADCASTING.

A $20,000 radio broadcasting station is to be erected at Kansas State Agricultural College, Manhattan. With the University of Kansas building a similar station, the State is claiming first place in broadcasting stations in State institutions. It is expected by staging "contests in the air" that listeners-in will experience some of the thrills of the onlookers and that it may be one of the means of bridging the gap between the "town and the gown."

PRACTICAL FIELD GEOLOGY IN SUMMER QUARTER.

Numerous courses in field geology were given in the summer quarter at the University of Chicago this year, one of which was a study of igneous and sedimentary rocks and varied phases of glacial drift near Devils Lake, Wis. At the Missouri field station in St. Genevieve County, Mo., each member of the class prepared a finished geological map of the area studied, showing the stratigraphy and structure of the region. One class studied fossil plants and their use in coal geology in the Des Moines formation in southern and central Iowa, another made a field expedition for research in vertebrate paleontology in western Nebraska and the adjacent portions of Wyoming, and a party of 12 men made an expedition in the Telocaset Quadrangle of the Blue Mountains of Oregon, the geology of which has never been mapped.

WORTH OF LEGION'S ESSAY CONTEST DEMONSTRATED.

Increasing interest is shown by the school children of the Nation in the national essay contest sponsored by the American Legion to encourage higher education and stir a keener patriotism in the citizens of to-morrow. The number of manuscripts submitted for the third competition, which closed recently, is estimated to be 40 or 50 per cent greater than that for the preceding year.

Subjects chosen are such as will lead the contestants to focus their thought upon questions of practical national policy. The topic for the second contest was "Why America should prohibit immigration for five years." That for the third competition was "Why communism is a menace to Americanism."

"The worth of the essay contest sponsored by the Legion is demonstrated," a Government official who comes in close contact with educational problems has said, "by the high character and large number of the contestants. The value of this competition in building up a better type of citizenship and in stirring these young people to take thought during the formative years of their lives for their country's future and for the questions which it must meet can not be doubted."—[*School Life.*

A PROCLAMATION BY THE PRESIDENT OF THE UNITED STATES OF AMERICA.

Education for the children of all the people, extending from the primary grades through the university, constitutes America's noblest contribution to civilization. No child or youth in the United States need be deprived of the benefits of education suited to his age and degree of advancement.

Nevertheless, either through negligence or because of unfortunate circumstances which might be controlled with sufficient effort, large numbers of children do not receive the full preparation for their life's work to which they are justly entitled. Many have reached maturity without even the rudiments of education.

This condition demands the solicitude of all patriotic citizens. It involves not only the persons immediately concerned and the communities in which they live, but the Nation itself, for the welfare of the country depends upon the character and the intelligence of those who cast the ballots.

Education has come to be nearer to the hearts of the American people than any other single public interest. The plan of maintaining educational institutions from public funds did not originally prevail in most of the States, and even where it was in use it was but feebly developed in the early days of the Republic. That plan did not arise spontaneously in the minds of all citizens. It was only when the suggestion came forcefully, convincingly, and repeatedly from a few pioneers that popular interest was fully aroused. Vigorous campaigns were required not only to establish the idea of public education, but also for its maintenance, and for its important extensions.

Campaigns of national scope in behalf of education have been conducted annually since 1920, and they have been increasingly effective with each succeeding year. They have concentrated attention upon the needs of education, and the cumulative impetus of mass action has been peculiarly beneficial. It is clearly in the interest of popular education, and consequently of the country, that these campaigns be continued with vigor.

In the last few years we have placed much emphasis on vocational training. It is necessary for men to know the practical side of life and be able to earn a living. We want to have masters of our material resources. But it is also necessary to have a broad and liberal culture that will enable men to think and know how to live after they have earned a living. An educated fool is a sorry spectacle, but he is not nearly so dangerous to society as a rich fool. We want neither in this country. We want the educated to know how to work and the rich to know how to think.

Now, therefore, I, Calvin Coolidge, President of the United States of America, do designate November 17 to 23, inclusive, as American Education Week. I urge that the citizens do all they can to advance the interests of education. It is especially recommended that the Governors of the states issue proclamations emphasizing the services rendered by their educational institutions, and calling upon their people to observe the occasion by appropriate action. Further, I urge that all civil officers whose duties relate to education, and all persons connected with the profession of teaching, exert themselves to diffuse information concerning the condition and needs of the schools and to enhance appreciation of the value of education. Patriotic, civic, religious, social, and other organizations could contribute by conducting meetings and demonstrations to promote the desire for knowledge. Ministers of religion and

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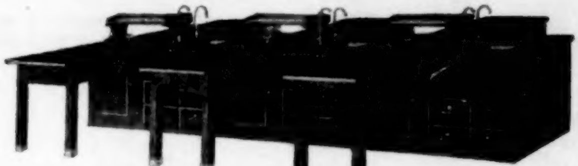

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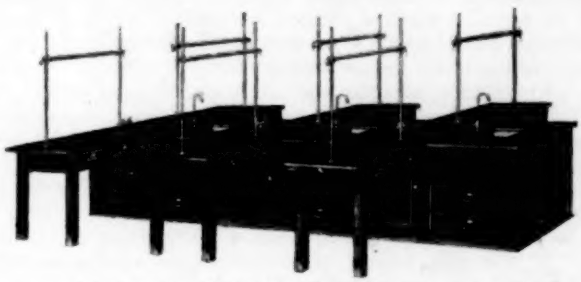

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members of the press are asked to exercise the means within their powee to increase enthusiasm for educational advancement and to stimulatr zeal for enlightened citizenship.

In witness whereof, I have hereunto set my hand and caused the seal of the United States to be affixd.

Done in the City of Washington on this fourteenth day of November in the year of our Lord One Thousand Nine Hundred and Twenty-four and of the Independence of the United States the One Hundred and Forty-ninth.

(Signed) CALVIN COOLIDGE.

By the President:
Charles E. Hughes,
Secretary of State

UNIQUE BIRDS OF CHILE DESCRIBED BY NEW YORK SCIENTIST.

Remarkable birds of the Pacific coast of South America, including a wild duck that cannot fly, a penguin that makes its nest in the midst of a jungle instead of on a rocky islet where one would expect to find penguins, and gulls that are a menace to sheep, were recently told about before the American Ornithologists' Union by Dr. Frank M. Chapman of the American Museum. Dr. Chapman has recently returned from a rapid study tour of the waters and coast lands of western South America.

The coast of Chile, he said, is especially well adapted for the study of bird life and other natural history problems. In the first place, the climate ranges all the way from very wet in southern Chile to absolute rainlessness in the nitrate deserts of the north. Then, the sea penetrates deep into the Andes range, and indeed in the southern part actually pierces it in several places, so that products of southern Patagonia can be loaded on ships from the Pacific. These long fjords, as well as Magellan strait itself, are simply flooded mountain valleys, and the offshore islands are simply isolated peaks and ranges.

Among the most interesting of the birds studied and photographed by Dr. Chapman was the loggerhead duck, also called the steamer duck, because of its peculiar method of half swimming and half flying. Its body is much too heavy for its short wings, often weighing ten or twelve pounds, and when it beats the air with its wings it rises partly out of the water, like a hydroplane, and thrashes up so much spray that it suggests the action of a sidewheel steamer, whence its name, "steamer duck."

The Chilean penguin is closely related to the penguins of the Antarctic region but instead of living on rocky islands in great rookeries near the shore, builds its nest in almost impenetrable jungles on forested islands. And though the forests are of a semi-temperate zone type, they harbor such birds as parrots and humming birds, most unlikely companions for penguins. "It was like finding polar bears and elephants together," said Dr. Chapman.

The sheep ranchers of Patogonia are much disturbed over two birds, the speaker continued. One of these is the kelp goose, a large and very beautiful bird, and much devoted to his family. But the goose eats a great deal of grass—six geese as much as one sheep, the ranchers say—and hence is regarded as an enemy. The second bird that is "in bad" with the sheep men is the black-and-white Dominican gull. These birds have thriven marvellously on the offal of packing plants of the region and have become very numerous. But the sheep raisers claim that when their usual bounty of offal runs low the gulls attack and devour young lambs. So geese and gulls are both under the ban in Patogonia. —[*Science Service.*

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REINDEER IN ALASKA.

Domestic reindeer herds in Alaska are now worth $1,550,000 more than the United States paid to Russia in 1867 for the entire territory, announced the Bureau of Education of the Department of the Interior in its annual report for the past fiscal year.

Of the whole number of reindeer, approximately 350,000, about 235,000 are owned by natives. The deer supply to their owners not only food and clothing, but a livelihood. The entire industry has developed since 1892, when the Bureau of Education began to import the animals from Siberia. The herds extend from the Arctic to the Pacific Ocean, and in the interior from The Alaska Railroad to the Aleutian Islands. The present problem which confronts the Bureau of Education in this connection is to reorganize the industry on a co-operation basis so as to handle the increasing herds more efficiently and to market the meat more economically. Already reindeer venison is appearing frequently as a "special" in high grade restaurants and dining cars of the northwest and its general use in the States will soon be merely a matter of transportation.

The Bureau of Education is charged by law with the education and welfare of the natives of Alaska, and the introduction of reindeer is but a part of its work in their behalf. Schools, hospitals, and cooperative commercial enterprises are also included. The Commissioner in his report lays stress upon the reorganization of this work which has recently been undertaken, and especially upon the introduction of modern methods of industrial training. The changes extend to all the schools more or less, but the most striking innovation is the establishment of industrial boarding schools at Eklutna, Kanakanak, and White Mountain.

The principal activities of the Bureau of Education are in behalf of the schools of the Nation as a whole. The Commissioner states that in this respect the situation is more promising than at any other time in its existence. The removal of the office from the unsatisfactory quarters it occupied in the Pension Building to the commodious new building of the Interior Department has improved in a marked degree the efficiency and morale of the bureau's staff, and has added distinctly to the facilities of cooperation with the officers of the department and of related bureaus.

Its publications have always been and will probably continue to be the principal means by which the influence of the bureau is exerted, but with increased appropriations and better organization, the Commissioner says that the personal element is entering more and more into its achievements.

Educational surveys, which depend upon personal examination of local conditions and recommendations for changes, have become a popular instrument of improvement. In this the Bureau of Education was the leader in point of time, and now directs more surveys of this character than any other agency—perhaps more than all others combined.

During the fiscal year 1924 it conducted 18. Of these the survey of higher education in Massachusetts is easily the most important, in the Commissioner's opinion, for it will probably lead to a complete change in the policy of the State toward higher education. A state-wide survey of the higher institutions of Tennessee and a survey of higher education in Cleveland, Ohio, are still in progress. A survey made of the school buildings of Portland, Oregon, is of equal importance in another direction, inasmuch as it involves the reorganization of the schools of the city.

Conferences of specialists in certain lines of education are frequently alled by the Commissioner of Education, who considers this is an effective method of diffusing information of value to the country. The

National Conference of Illiteracy, held in the Auditorium of the Department of the Interior in January was a conspicuous example of such conferences, both because of the high character of the participants and of the results that may be expected to come from it. The summer meeting of the National Educational Association, which was held in Washington, afforded the Bureau of Education a valuable opportunity to come in contact with the teachers of the country.—[*Department of the Interior.*

AGRICULTURAL CONDITIONS TRANSFORMED WITHIN SIXTY YEARS.

Transforming the farmer from the "toil calloused, broken laborer" of Carlyle's time to the man of culture, "not to be distinguished from the brain-worker in bearing or in breadth of scholarship is the miracle of education in vocation," as Eustace E. Windes expresses it in *School Life*, a periodical published by the Bureau of Education, Department of the Interior.

After sixty years of agricultural education fostered by the National Government and by State agricultural colleges and experiment stations great changes have been wrought. The American farmer to-day expends less than 20 per cent of the labor in producing the nine principal crops of the country that his predecessor expended in producing the same quantity of these crops in 1850. He produces 2.3 times what the farmer of the United Kingdom produces, 2.5 times what the French farmer produces, and 6.5 times what the Italian farmer produces.

BOOKS RECEIVED.

Laboratory Problems, by Otis W. Caldwell, Teachers' College, Columbia University; W. L. Eikenberry, State Normal School, East Stroudsburg, Pa.; Earl R. Glenn, Teachers College, Columbia University. Pages IX plus 196. 13½x19¼ Cm. $0.72. Ginn & Co., Boston.

Chemistry Experiment Sheets, Martin Mendel, Jamaica High School, Jamaica, N. Y.; Milton B. Brundage, Stuyvesant High School, New York City. Pages VI plus 120. 21x26 Cm. Fordham Publishing Co., New York.

The Science of Common Things, Samuel F. Tower, English High School, Boston, Mass.; Joseph R. Lunt, English High School, Boston, Mass. Pages VI plus 398. 19x13 Cm. Cloth. 1924. D. C. Heath and Company, Chicago.

The Mathematics of Investment, William L. Hart, University of Minnesota. Pages XI plus 200 plus 88x14x21 Cm. Cloth. 1924. D. C. Heath and Company, Chicago.

Geography—Journeys in Distant Lands, Harlan H. Barrows, University of Chicago; Edith P. Parker, University of Chicago. Pages VIII plus 152. 26x20½ Cm. Cloth. 1924. Silver Burdett & Co., Chicago.

Unit Studies in Geography, Rose B. Clark, Nebraska Wesleyan University. Pages VI plus 250. 20x13½ Cm. Cloth. 1924. Yonkers-on-Hudson, New York, World Book Co.

Modern Junior Mathematics, Marie Gugle, Columbus, Ohio. XXII plus 310 pages. 13x19 Cm. Cloth. 1924. Gregg Publishing Co., Chicago.

The Graphic Construction of Eclipses and Occulations, Wm. F. Rigge, Creighton University, Omaha, Nebr. Pages 157. 17x25 Cm. Cloth. 1924. Loyola University Press, Chicago, Ill.

BOOK REVIEWS.

Fundamentals of Chemistry. A Text-Book for Nurses and Other Students of Applied Chemistry. By J. Lean Bogert, Ph.D. Research Chemist, Obstetrical Department, Henry Ford Hospital, Detroit. 12 mo. of 324 pages, illustrated. Cloth. 1924. $2.75. W. B. Saunders Co., Philadelphia and London.

This text is intended specifically for nurses in training. Since what they need most is applied chemistry, and since they usually have no knowledge of chemistry to apply, it becomes necessary to give them first some of the elements of the science to be followed later by some account of its applications to nursing. The time available for this task is usually so limited that the acquirement of the fundamentals must become more or less of a cramming process. In reviewing this book it appears that, with the above limitations in mind, the author has done a rather good job of condensing much material into relatively little space. The presentation is of necessity systematic and after the manner of the college approach rather than like the usual high school method. One cannot but wish that the nurses who are to take the work had had in high school a more leisurely approach to some of the difficulties of the subject. The handling of the applied chemistry in the latter part of the book is excellent. As a reference book for use in high school libraries the text would have some value for its condensed account of physiological chemistry.

F. B. W.

Fundamentals of Chemistry, by Carl William Gray, Head of Chemistry Department, Hollywood High School, Los Angeles, Claude W. Sandifur, Head of Home Physical Sciences, Hollywood High School, Los Angel and Howard J. Hanna, Head of Chemistry Department, Los Angeleess High School. 1st edition. pp IX plus 455.13. 5x19.5x3 cm. Illustrated. Cloth 1924. $1.68. Houghton, Mifflin Co., Boston.

This new high school text has much of originality in its method of presentation of the fundamentals of elementary chemistry. It is full of interesting applications of chemistry to daily life and is well illustrated with up to date pictures and drawings. Its first approach to the subject, after a very brief historical chapter, is by way of a study of matter and energy (which might have waited) and then metals in general constitute the first materials to be considered. This method has the merit that the metals are familiar and tangible materials. Metallic oxides naturally follow. A study of these leads to the study of oxygen, a non metal. As this is easily obtained from water we are next led to study that and hydrogen follows. It will be seen from the foregoing account that a natural rather than a systematic route is followed.

Hydroxides, the non metals sulphur and phosphorus, ionization, the nonmetallic oxides, equations, acids and bases follow. After the fundamentals are treated much of the remainder of the book is devoted to applications of chemistry to life.

It is interesting to note that some space has been given to an elementary presentation of the subject of sub atomic structure. The chapter on the periodic law is chosen for this presentation. Radio activity is also discussed with the atomic disintegration explanation. In view of the results of the questionnaire on "Should the Electron Theory be included in High School Chemistry?" (reported in the Journal of Chemical Education for September, p. 145) in which 74 per cent of the answers

favored some mention of it, this inclusion of the subject in a new text book would seem to be quite in order. In view of its original treatment of the subject of elementary chemistry all high school chemistry teachers should see this text.

F. B. W.

Laboratory Manual, by Carl William Gray and Claude W. Sandifur, to accompany Gray, Sandifur and Hanna's "Fundamentals of Chemistry." pp LX plus 137. 19x23.5x.75 cm. Diagrams of apparatus. Semi-flexible board covers, 1924. $0.92. Houghton, Mifflin Co., Boston.

An Elementary Study of Chemistry, Introductory College Course, by William McPherson and William Edwards Henderson, Ohio State University. 3d edition completely revised and rewritten. pp X plus 628. 14x20x3 cm. Ill. Cloth, 1924. $2.40. Ginn & Co., Boston.

This college text was prepared largely with a view to the needs of those college students who have not had a high school course in chemistry. This does not in the least unfit it for those who have had such a course for it has been the experience of many a student that the first course in chemistry in college was too stiff for his then stage of maturity and of ability to grasp the rather difficult principles and theory of chemistry.

In the rewriting of the text the general order of treatment has been left approximately as it was but much new material has been added. It is thus brought down to date. For example, in the chapter on periodic law an excellent brief synopsis of the physics of the atom has been placed. Radioactivity too has been briefly but excellently treated. Colloids have a chapter of their own in which a good condensed account of their characteristics and of their importance is given. Many new illustrations have been added. Every college teacher of chemistry will want to see this new edition.

F. B. W.

Smith's Elementary Chemistry, revised and rewritten by James Kendalel Professor of Chemistry, Columbia University, wih the collaboration of S. Walter Hoyt, Mechanic Arts High School, Boston, Mass., J. Colin Moore, Crane Junior College, Chicago, Ill., J. M. Kelso, Sacramento High School, Sacramento, Cal., Ellinor Garber, Shortridge High School, Indianapolis, Ind., and Ray McClellen, Liberty Memorial High School, Lawrence, Kansas. pp XIV plus 423. 13.5x19.5x2.75 cm. Ill. Cloth, 1924. The Century Co.

We have here the first of two revisions of Alexander Smith's Elementary Chemistry. This edition is a logical presentation of the subject, as was the original book. It is however thoroughly re-written and, as noted above, with the assistance of a very competent corps of secondary school teachers to give it the benefit of their experience with high school pupils.

Another edition will follow in which the technical view will be subordinated to the cultural. The major emphasis in the second book will be placed, not upon the derivation of the principles themselves, but rather upon their human and industrial applications.

As for the present book a glance at the very beginning shows that the spirit of approach to the subject is one which will naturally interest the youngster. A piece of cloth is tested out to see if it is "all wool" and in the testing there comes an opportunity to teach the essential ideas of "substances" and "properties" of "mixtures" and of "chemical change." Rusting is next taken up and the loss in volume of air exposed

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to rusting iron, and the gain in weight of the iron, furnish facts about the air, and the notion of "combination" as a type of chemical change. So much for the approach. The treatment throughout is adequate. Modern notions in regard to radio activity are given in one of the late chapters but subatomic structure and its relation to valence and to the periodic law have been avoided (A foot note at one point tells us that it is with reluctance that this is done but the subject is in such a state of flow at present that it was thought wise to omit it for the present in an elementary text).

Although not a descriptive text there is a large amount of descriptive matter included by way of illustration and there is also much applied chemistry with many excellent pictures of manufacturing equipment.

A laboratory manual, bound separately, in cloth with IX plus 112 pp is ready for use with the text. It contains 72 exercises, and is well prepared. Secondary school chemistry teachers will, of course, want to see this new "Smith" text with its value heightened by the work of Kendall and his collaboratories.

F. B. W.

Laboratory Manual of Chemistry, by George H. Bruce, Department of Chemistry, Horace Mann School for Boys, Teachers College, Columbia Universiy. 1st Edition. pp X plus 120. 20.5x26.5x1 cm. Illustrated with drawings of apparatus. Loose leaf, two perforations for rings, flexible board covers, 1924. $1.20. World Book Co., Yonkers on Hudson, N. Y., and 2126 Prairie Ave., Chicago, Ill.

This new manual contains directions for the performance of sixty experiments. They satisfy the requirements of the College Entrance Examination Board. The manual has its directions on the left hand page and the right hand page is left blank for the "write-up" of the experiment. A glance at the character of the directions shows that they are clear and easily understood. Leading questions placed at strategic points help to direct the course of thought of the pupil. Cautions are given when necessary. In the preparation of oxygen, in addition to the usual use of Potassium chlorate with manganese dioxide we note that each of the two substances is heated separately before the two are used together, giving the pupil a better chance to appreciate the marked effect of the addition of manganese dioxide to the potassium chlorate. Lead peroxide is also heated to prepare oxygen thus acquainting the pupil with one of the substances used by Scheele and by Priestly in their historical preparations of oxygen.

The whole manual is a conservative presentation of the essentials of a secondary school course in chemistry laboratory work.

F. B. W.

Insect Life, by Walter W. Krueger, Central High School, Grand Rapids, Mich. Paper covers, size 15x38 cm. Pages 74, 1924.

This is a hand book of insects, giving much useful information for those interested in their study. We think it might be a very good reference book for use in high school zoology. A list of some of the chapter heads will give a good idea of the intent of the author: "Habits and behavior of the honey bee." "Insects and the pollination of flowers." "Insects that Spread Disease." "How Insect Offect Crops and Trees," These are samples of the eleven chapters in the book. There are also extensive reference list and many helpful suggestions for study.

W. W.

Western Forest Trees, a guide to the identification of trees and woods, by James Berthold Berry, M. S. County Vocational Supervisor, Pennsylvania. Cloth, size 13x18 cm. Pages XII+212, with 96 figures. Published by World Book Company, Chicago, Ill., and Yonkers-on-the-Hudson, N. Y., 1924. Cost $1.20.

This is a companion volume to "Northern Woodlot Trees" by the same author to accompany his handbook, "Farm Woodlands." The book is well written and well printed. The illustrations are clear and numerous, showing specimens of the wood, fruit, and branches with leaves of the trees described. It is a good book and will be useful to those interested in Western trees.

W. W.

Principles of Animal Biology, by A. Franklin Shull, Professor of Zoology University of Michigan, with the collaboration, George R. Larue and Alexander G. Ruthven, University of Michigan. Cloth, size 14 cm. x 22 cm. Pages XVIII+422, with 270 charts and illustrations. Second edition. Published by McGraw-Hill Book Company, Inc., New York, 1924. Cost $3.50.

This is an introductory text for college use, prepared by the authors for their classes in the University of Michigan, and is the outgrowth of several year's use and development. The book introduces the study of animals by the study of principles, abandoning the time-honored method of type dissections. We quote a few of the chapter heads: "Morphology of the Cell;" "Physiology of the Cell;" "Cell Division;" "Origin of Metazoa;" "Reproduction;" "Breeding Habits of Animals;" "Genetics;" "Fossil Animals;" closing with a chapter on "Evolution."

The book is highly technical and we conclude that only very courageous freshmen would undertake the course if they knew beforehand the nature of the presentation. There are 42 pages of glossary with approximately 1200 technical terms defined. It goes without saying that the discussions of the various topics are very thorough even if also very technical. The readers of this *Journal* are, however, secondary school teachers and for them it will be a worth-while reference book up-to-date with current progress in the science.

W. W.

Plant Anatomy and Handbook of Micro-technic, by William Chase Stevens, Professor of Botany, University of Kansas. Fourth edition, revised. Cloth. XV plus 398 pages, with 155 illustrations. Size 14 cm. x 23 cm. Published by P. Blakiston's Son & Co., 1924.

This is a revised edition of a well-known standard work. Various questions which have been debated in recent time and brought nearer to solution are discussed in the light of this newer data. The book is beautifully printed and illustrated and the author's style is so simple and clear that it is a pleasure to read the text.

W. W.

Physiology and Hygiene, by Frances M. Walters, A. M., State Teachers' College, Warrensburg, Mo. Revised edition. Cloth. Illustrated with 164 figures. Pages VIII plus 426. Size 13x18 cm. Published by D. C. Heath & Company, 1924.

This is an elementary textbook of human physiology and hygiene for secondary school. Our examination convinces us that this is a good textbook. The subject matter is written clearly and developed in an orderly way. There is good use of leaded and italicized type and short summaries and statements. We think it a very teachable book and heartily recommend its consideration where such a text is needed.

W. W.

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